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PROCEEDINGS

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VOL. XXVIII SECTION-B PART VI

STUDIES ON THE NUTRITION OF FUNGI

III. THE INFLUENCE OF DIFFERENT SOURCES OF CARBON ON THE GROWTH OF THREE ANTHRACNOSE FUNGI

By

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Received on 21st November 1958

The first two papers from this laboratory deal with the carbon and nitrogen nutrition of *Colletotrichum capsici* (Thind and Randhawa, 1957, 1957b). This paper deals with the carbon nutrition of three more anthracnose fungi, *Gloeosporium psidii*, *G. piperatum* and *Colletotrichum* sp.*

MATERIAL AND METHODS

Monosporic isolates of three anthracnose fungi, *G. psidii*, *G. piperatum*, and *Calletotrichum* sp. were made from the local orchards and local crops during 1956-57. Rapidly growing and abundantly sporulating forms were maintained for further studies. The basal medium (dextrose 10 gm., KNO_3 5 gm., KH_2PO_4 5 gm., $MgSO_4 . 7H_2O$ 1 gm., $Fe_2(SO_4)_3 . 6H_2O$ 0·005 gm. and distilled water 1,000 mls.) was employed in the present investigations, and it was found to be quite suitable for

*Collecetion on *Citrus aurantifolia* and *C. limon* and probably is a new species (Thind and Rawla—Indian Phytopathology, in Press).

the growth of these fungi. Dextrose was replaced by each carbon compound so as to provide the same amount of carbon as is present in 10 gm. of this sugar. The various media were then adjusted to pH 6, using a Beckman pH meter, after autoclaving for thirty minutes at 5 lbs. pressure. Three replicates were taken for each carbon compound and for each pathogen. Fifty millilitres of the media were poured into a 250 ml. Erlenmeyer flask.

The spore suspensions were prepared separately at the rate of 5 spores per field of the low power of the microscope for each pathogen. The media, after seeding with 1 ml. of the standardized spore suspensions of different fungi, were incubated for 10 days at 28°C. These conditions have been found to be optimum for the growth of these fungi by preliminary experiments. After this period the dry weight of the mycelium and final pH were determined. The cultures were filtered through previously dried and weighed Watsman filter paper No. 1, dried to a constant weight in a hot air oven at 70°C, and weighed in an analytical balance after allowing to cool in a desiccator.

EXPERIMENTAL WORK

Twenty carbon compounds, comprising 18 carbohydrates, 1 oil and 2 alcohols were tested as sole sources of carbon for the mycelial growth of three anthracnose fungi. The basal medium (excluding dextrose) as well as various carbon solutions in distilled water were sterilized at 5 lbs. pressure for thirty minutes separately and then mixed together asceptically. Each carbon compound* was added at a concentration calculated to provide 200 mgs. of carbon per 50 ml. of the basal medium. The various media in flasks were adjusted to pH 6 and seeded with 1 ml. of the standardized spore suspensions of the different pathogens and incubated at 28°C for 10 days. The maximum dry weight of these fungi was recorded by this time. On the final day, growth characters and shifts in pH were recorded, the fungal crops were filtered and dried to a constant weight. Data on dry weight and final pH are presented in table I.

EXPERIMENTAL RESULTS

The study of table I reveals that nearly all the carbohydates supported fair to good growth of these pathogens. No growth however, occurred in the medium without the carbon source, which served as a control. Best mycelial growth of these fungi occurred with dextrose, fructose, d(+)mannose, melezitose and raffinose ; fair to good with l(+)arabinose, xylose, sucrose, cellobiose, maltose and melibiose ; poor with lactose, inulin, pectin and castor oil.

Dulcitol, mannitol and soluble starch supported poor growth with *G. piperatum* and *Colletotrichum* sp. but gave fair growth with *G. psidii* only.

Good growth was observed with l(+)sorbose in the case of *G. psidii* and *G. piperatum*, but *Colletotrichum* sp. gave poor growth with this sugar. D(+)galactose yielded good growth with *G. piperatum* ; fair with *G. psidii* and poor with *Colletotrichum* sp.

Floating growth was observed in the case of all these fungi only with xylose, dextrose, fructose, d(+)mannose, sucrose, melibiose and raffinose ; in the case of *G. piperatum* and *G. psidii* with l(+)arabinose, l (+) sorbose, lactose, cellobiose, maltose, melezitose and starch ; in the case of *G. piperatum* with cellobiose and maltose ; in the case of *Colletotrichum* sp. with pectin and starch.

*Starch, inulin, and pectin were added at the rate of 10 gm. each per litre of the basal medium.

TABLE I

Average dry weights and final pH of *G. psidii*, *G. piperatum* and *Colletotrichum* sp. after 10 days of incubation at 28 C, initial pH adjusted to 6.

Carbon source		*G. psidii* Mean		*G. piperatum* Mean		*Colletotrichum* sp. Mean	
		dry weight (mgs)	Final pH	dry weight (mgs.)	Final pH	dry weight (mgs.)	Final pH
Control	...	—	6	—	6	...	6
MONOSACCHARIDES							
A. *Pentoses*							
l(+) arabinose	...	130	6·6	150	6·6	95	6·6
Xylose	...	90	7·4	140	6·3	150	6·6
B. *Hexoses*							
Dextrose	...	105	6·6	140	6·1	180	7·5
Fructose	...	110	6·0	150	6·0	150	6·3
l(+) sorbose	...	115	6·0	130	6·0	75	6·0
d(+) galactose	...	70	7·6	180	6·0	50	6·3
d(+) mannose	...	110	7·2	170	6·6	140	6·9
DISACCHARIDES							
Sucrose	...	90	6·5	130	6·1	120	7·3
Lactose	...	60	6·0	60	6·0	50	6·0
Cellobiose	...	80	7·6	115	7·0	115	7·6
Maltose	...	80	7·0	150	6·8	110	7·7
Melibiose	...	90	7·1	120	6·8	100	7·4
TRISACCHARIDES							
Melezitose	...	120	6·7	170	6·7	130	7·0
Raffinose	...	110	6·3	160	6·3	180	6·5
POLYSACCHARIDES							
Soluble-starch	...	80	6·6	30	6·3	62	7·5
Inulin	...	20	6·0	25	6·0	20	6·0
Pectin	...	40	7·2	60	7·2	60	6·5
OILS							
Castor oil	...	32	6·0	30	6·0	35	6·0
ALCOHOLS							
Dulcitol	—	110	6·2	20	6·0	15	6·0
Mannitol	—	90	6·0	30	6·0	55	6·0

Totally submerged growth of all of these fungi was observed with inulin, castor oil, dulcitol and mannitol ; *Colletotrichum* sp. showed only submerged growth with galactose, lactose and maltose ; *G. piperatum* and *G. psidii* with starch and pectin respectively.

Growth was dull white to grey with all of these pathogens. Numerous black acervuli with pink spore masses appeared in the case of *Colletotrichum* sp. with l(+) arabinose, d(+) mannose lactose, cellobiose, melibiose, melezitose and starch and in the case of *G. piperatum* with l(+) sorbose and pectin only.

DISCUSSION

These fungi showed good growth with arabinose and xylose, which have generally been reported to be the poor sources of carbon for many fungi by different authors such as *Pythium* spp. (Saksena, 1940), *Alternaria tenuis* (Tandon and Grewal, 1954), *Phlyctorhiza* (Rothwell, 1956), Saprolegniaceae (Bhargava, 1945). In this respect these fungi resemble *Glomerella cingulata* (Hawkins, 1915), *Sclerotium delphinium* (Perlman 1948) *Colletotrichum phomoides* (Hendrick and Walker, 1948). *Colletotrichum papayae*, *Gloeosporium papayae* and *G. musarum* (Grewal, 1957).

Like *Aspergillus niger* (Steinberg, 1939), l (+) sorbose was moderately utilized by *G. psidii* and *G. piperatum*, but *Colletotrichum* sp. produced good growth with this hexose sugar as is also the case with *Fusarium oxysporium* (Wolf, 1955), *Colletotrichum capsici* (Thind and Randhawa, 1957).

D (+) galactose is a fairly good substitute of glucose for *G. psidii* and *G. piperatum*, as has also been observed with *Gloeosporium psidii* (Tandon and Aggarwal, 1954, and Thind and Sandhu, 1956), *Gloeosporium* spp. and *Colletotrichum papayae* (Grewal, 1957), while *Colletotrichum* sp. made poor growth with this sugar and in this respect resembles *A. niger* (Steinberg, 1939), *Blastocladia* (Craseman, 1957), *Leptomitus lacteus* (Schade, 1940).

These fungi use lactose poorly as is also observed with *Colletotrichum indicum* (Ramakrishnan, 1947), *C. capsici* (Thind and Randhawa, 1957), *F. oxysporium* (Wolf, 1955). In this respect these fungi differ markedly from *C. phomoides* (Hendrick and Walker, 1948), three anthracnose fungi (Grewal, 1957), which have shown best growth with this sugar.

Leben and Keitt, 1948, Thind and Randhawa, 1957, have shown *Venturia inaequalis* and *C. capsici* respectively to give good growth with pectin, but these fungi utilized pectin poorly as is also the case with *Blastocladia* (Craseman, 1957).

Inulin is not utilized by these fungi as is also observed with *Colletotrichum papayae*, *Gloeosporium* spp. (Grewal, 1957), *C. capsici* (Thind and Randhawa, 1957), *Pythium* and *Phytophthora* spp. (Saksena and Mehrotra, 1949), *A. tenuis* (Tandon and Grewal, 1954), *Pythium* spp. (Saksena, 1940). However, this polysaccharide is reported as a good carbon source for *Phymatotrichum omnivorum* (Moor, 1937), *G. psidii* (Tandon and Aggarwal, 1954), *Gloeosporium* spp. (Tandon and Aggarwal, 1956).

In supporting poor growth with soluble starch *G. piperatum* and *Colletotrichum* sp. resemble three anthracnose fungi (Grewal, 1957), while *G. psidii* made a fair growth with this polysaccharide, thus closely agreeing with *V. inaequalis* (Leben and Keitt, 1948), *A. tenuis* (Tandon and Grewal, 1954).

G. piperatum and *Colletotrichum* sp. made a poor growth with dulcitol, but *G. psidii* supported good growth with this alcohol as is also observed with *Monosporium apiospermum* (Wolf *et al*, 1950), *A. tenuis* (Tandon and Grewal, 1954), *C. psidii* (Thind and Sandhu, 1956). Mannitol is a good source of carbon for *Gloeosporium* spp. (Tandon and Aggarwal, 1956), 3 anthracnose fungi (Grewal, 1957). *G. psidii* closely resembles the above mentioned fungi in supporting good growth with mannitol. However, G. *piperatum* and *Colletotrichum* sp. yielded poor growth with this alcohol as is also the case with other fungi investigated by Wolf and Schoup, 1943 and Rothwell, 1956.

SUMMARY

A comparative account of studies on the carbon nutrition of G. *psidii* (from guava), *G. piperatum* (from chillies) and *Colletotrichum* sp. (from citrus) were undertaken. The study was carried out at 28°C for 10 days with initial pH of the medium always adjusted to 6. Of the twenty carbon compounds tested as sole sources of carbon for the growth of these fungi, best mycelial growth occurred with dextrose, fructose, d (+) mannose, melezitose and raffinose; fair to good with l (+) arabinose, xylose, sucrose, cellobiose, maltose and melibiose; poor with lactose, inulin, pectin and castor oil. Dulcitol, mannitol and soluble starch supported poor growth with *C. piperatum* and *Colletotrichum* sp. but gave fair growth with *G. psidii* only. Good growth was observed with l (+) sorbose in the case of *G. psidii* and *G. piperatum*, but *Colletotrichum* sp. gave poor growth with this sugar. D (+) galactose yielded good growth with G. *piperatum*; fair with G. *psidii* and poor with *Colletotrichum* sp.

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THE HILSA FISHERY AT ALLAHABAD

By

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Received on 10th September 1958.

INTRODUCTION

The Indian shad *Hilsa ilisha* is one of the most important food-fishes of India, and in spite of its numerous bones it is well-relished and is considered a delicacy throughout the country, and especially so in Bengal. Its fishery started receiving attention from the latter part of the nineteenth century. The credit of infusing interest in the Scientific workers for investigating various problems of *Hilsa ilisha* in India goes to the late Dr. S. L. Hora, Director Zoological Survey of India.

Among the important workers who have made noteable contributions to the study of the biology and fishery of this fish are Raj (1917), Hora (1938, 1940), Hora and Nair (1940a, 1940b) Chacko and Ganpati (1949), Kulkarni (1950), Jones (1951), Jones and Sujansinghani (1951), Ahmad (1954) and Pillay (1954).

At Allahabad, *Hilsa ilisha* provides the most important single fishery in August, September, October and a part of December. It exceeds in number the rest of the fishes caught from Ganga and its tributaries.

OCCURRENCE OF HILSA AT ALLAHABAD

The fish were collected by the author twice a week throughout the year from the rivers Ganga, Jamuna and their tributaries covering a radius of about 40 miles around Allahabad. Naturally, he is led to conclude that the statement of Kanshiva (1954) that there is no *Hilsa* fishing in Uttar Pradesh from July to September is completely erroneous. The number of Hilsa caught betweent February to August is comparatively very poor yet it has been observed that the fish is never totally absent from Allahabad waters of Ganga and its tributaries. The presence of *Hilsa* throghout the year lends support to the view that the *Hilsa* of higher reaches probably belongs to a different stock than those from the estuaries. The possibility of existence of different races has been envisaged by several authors including Day (1873).

STATISTICAL RECORD OF TOTAL CATCH

Due to want of effective organization no statistical records are available and essential data about the total catch and its disposal is lacking. Under the circumstances we have to rely on the information gathered from the fishermen and contractors dealing with this fish. Up to 1953, *Hilsa* fishery was more or less a seasonal fishery from August to November, with its peak in the last two months. The yield was much less and the number of fishermen interested in fishing was also correspondingly less. In the year 1954, as expected in accordance with the five year biologi-

cal cycle, *Hilsa* fishery at Allahabad struck a new record which had been abnormally high. Since then fishermen and contractors developed more interest in *Hilsa* fishery and now, as mentioned above, *Hilsa* is fished throughout the year. The fluctuation in the total yeild occured even before 1954, but in the absence of any record nothing can be said whether it was in agreement with the five-year biological cycle in *Hilsa ilisha.*

The following table, may give a rough idea of the fluctuations in total catch of *Hilsa* at Allahabad.

	1954	1955	1956
Januray	Data not available	2,500 Mds.	726 Mds.
February	—	62·0 ,,	459 ,,
March	—	276 ,,	810 ,,
April	—	54 ,,	237 ,,
May	—	12 ,,	138 ,,
June	—	18 ,,	126 ,,
July	—	93 ,,	136 ,,
August	1,800 Mound	111 ,,	145 ,,
September	3,300 ,,	1,545 ,,	384 ,,
October	11,300 ,,	2,838 ,,	7,266 ,,
November	6,500 ,,	1,689 ,,	3,681 ,,
December	3,800 ,,	1,371 ,,	8,751 ,,

From the table it is evident that the total catch was much less in 1955 and 1956 than that of 1954 the year of bumper yield. The data also shows that the catch in December 1956 was unusually high.

In 1956 the reivers Jamuna and Ganga were in spate for the second time in the month of October due to very heavy rains in the upper reaches. This state of river is uncommon. It seems, the flooded rivers *excited the fish* to ascend with much intensity beyond the usual limit of migration and as a result *Hilsa* has been reported as high as up to Etawah, 209 miles up from Allahabad on Jamuna and Chambal, one of its tuributaries.

The catch from Chambal and Jamuna at Etawah amounted to twenty to thirty maunds a day, and this condition persisted for about three weeks in November and December 1956. Never before this fish was reported in such large numbers from places so far up from Allahabad.

EXPORT OF HILSA

In 1954, about sixteen hundred maunds of *Hilsa* fish had been exported from Karchana, Manda Road, Aharaura Road and Jeonathpur Stations which are not usually the centres for the *Hilsa* export. About 12,200 maunds of fish had been

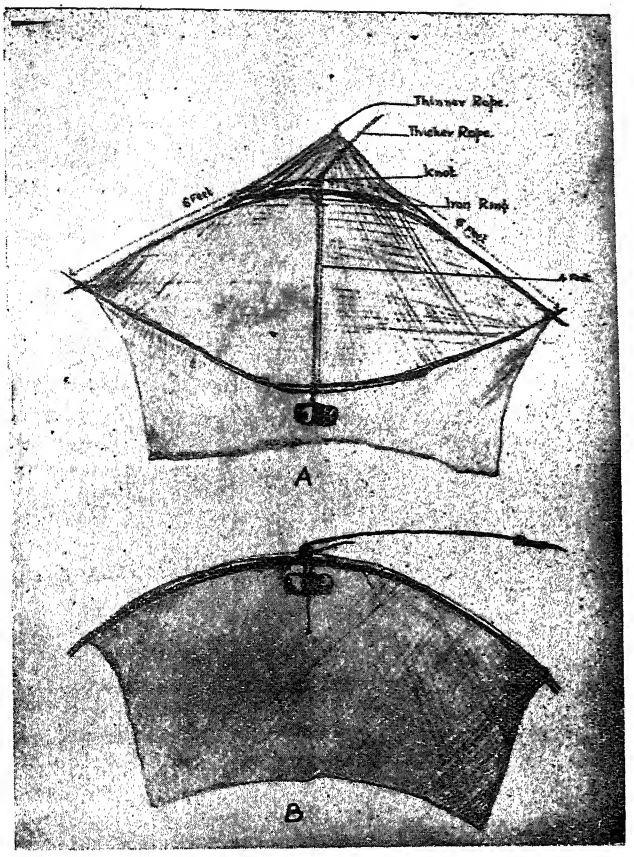


Fig. 1—Kamel net. In 'A' the condition of the net has been shown when suspended in water. The two arms are separate and they form the opening of the net 'B' denotes the figures when the two arms of the nets are clamped after the fish is caught.

Fig. 2—Photograph of the Kamel net in operation.

wasted for lack of proper facilities of transport and refrigeration. Under the circumstances *Hilsa* was sold even at the rate of Rupees five a maund.

Major portion of *Hilsa* caught around Allahabad in the rivers Ganga, Jamuna and their tributaries is exported and of the total quantity exported, 90% is exported to Howrah and from the remaining 10% the following markets are supplied.

1. Bardwan	2. Asansol	3. Jharia
4. Ranigunj	5. Siliguri, and	6. Dal Gaon

When Calcutta market, the chief consuming centre of *Hilsa* is dumped with its supply and the prices go down, supplies are made to Delhi, Kanpur and Lucknow.

The important centres from where the fish is exported are :—

(*i*) Allahabad	(*ii*) Karchana
(*iii*) Meja Road	(*iv*) Mirzapur
(*v*) Chunar, and	(*vi*) Banaras

The main fishing centres along the stretch of the river Ganga and its tributaries around Allahabad are :—

1. Daraganj	2. Rasulabad	3. Dropadighat
4. Newa	5. Begam Sarai	6. Lawain
7. Siniraha	8. Mobaiya	9. Diha
10. Dumduma	11. Lachhagir	12. Mirzapur
13. Chunar	14. Ramnagar	15. Siyabad
16. Bahadurpur	17. Baruna and Ganga confluence.	
18. Tonakpur	19. Tikri	20. Kunda
21. Kaithi	22. Gangapur	23. Balua
24. Arail	25. Mahadewan	26. Confluence of Ganga & Jamuna
27. Jalalpur	28. Sadiapur	29. Kaila Buxi
30. Baswar	31. Mahewa	32. Sirsa
	33. Baluha, and	34. Bhagwanpur

NETS USED FOR CATCHING HILSA

While dealing with the fishery of any fish, it is necessary to study the various methods employed in the capture of the fish. The capture methods reveal quite interesting and important facts about the bionomics of the fish concerned. *Hilsa ilisha* is fished by the following nets in Ganga and Jamuna waters at Allahabad.

1. KAMEL NET (Figs. 1 and 2). It has two arc shaped arms made of thin bamboo. To these arms are tied the free ends of the net. Each arm is about

12 feet long. In the middle of the lower arm a weight is tied by a long rope which passes through an iron ring fixed in the centre of the upper arm exactly opposit to the weight. A big knot is tied in the rope at a distance of about 4 ft. from the weight. This knot lies beyond the iron ring which is tied with the upper arm. There is another thin rope tied to the net at a distance of about 10—12 inches below the iron ring.

The fish shoals ascend the rivers during the months of August, September, October and November. Fishermen take advantage of this phenomenon and use the Kamel net at places where the river is considerably deep. This net is operated single-handed and only one fish is caught in one operation. The fisherman goes on a small boat up the river for about a mile or so and then throws his net in water and goes on loosening the ropes till the weight tied with the lower arm touches the river bed. Now he lifts the net by about 3—4 ft. above the bed of the river, because, while ascending the fish move closer to the bottom than to the surface, The net is then left in position 'A'. This position is maintained by loosening the thicker rope till the knot of the thicker rope comes to lie at rest at the iron ring. The thinner rope is tightened up and is used as indicator. The fisherman now sits quietly on his boat holding the ends of the two ropes and allowing the boat to drift with the current. Ascending fish gets into the trap and strike against the net, This sensation is felt by the fisherman through a jerk in the thinner rope. Immediately he leaves the thinner rope and pulls up the thicker one which results in clapping together of the two arms of the net (Fig. 1B); the fish is thus captivated in the net which is then pulled up (fig. 2).

It is a beautiful sight to observe hundreds of fishermen with their boats engaged in intensive fishing day and night. This method is exclusively used for fishing *Hilsa ilisha* in Allahabad.

2. *Bandal* (figs. 3 & 4).

This method of fishing is prevelent from the end of November to the end of April. It is a special device for catching *Hilsa* at Allahabad. Barriers of bamboo and stake are constructed in the river. One single 'Bandal' has two long rows of bamboo pitched against the current. They give an appearance of two converging arms of the letter V. A triangular net tied to a V-shaped bamboo frame-work is fixed at the point where two rows tend to meet. The two arms of the bamboo frame-work are tied on either side with a pole fixed in the river.

The point at which the arms of net are tied with poles act as lever and the net can be lowered and raised when desired by raising and lowering the V-shaped frame. Immediately behind, a platform is prepared on two pairs of poles fixed in the river (figs. 3 and 4). On this platform stands the fisherman who manipulates the net at regular intervals of 5—10 minutes. The fish during this period are known as 'Bahera', meaning thereby that having completely exhausted after spawning they move along the current of water with least effort. Bandal nets are fixed at places where river is shallow, say about 4 ft. deep; hence when the net is dropped into water, the lower portion almost reaches the bed of the river. Due to the V-shaped barriers the fish coming in the range of these two arms move towards the net and are ultimately caught. From this net they are taken out by a small hand net and kept in a big basket. Such Bandals are seen at interval of about 200 yds. from one another along the stretch of the river. Sometimes two 'Bandals' are planted side by side (VV) thus covering the entire breadth of the river.

Fig. 3—Bandal net. 'A' Diagrammatic representation of the Bandal net. 'B' indicates the position of the barriers in the river in February and March. Due to the barrier the fish turn back and are caught in the Bandal.

Fig. 4—Photographs of the Bandal net in operation.

During February and March which is the minor peak breeding season the fish move both ways. The spawners ascend and those that have spawned come down. For 'Ujani' *i.e.* the ascending fish the barrier arraugement is changed as shown in fig. 3B. In this way for sometime in Mareh two types of 'Bandal' work. In Tons one of the tributaries of Ganga in Allahabad this method of fish capture has been reported even in May and June. Fishing by this method is done day and night and a batch of few fishermen change duty one after another to operate the net.

3. *Drag Net* (Mahajal).

This net is not meant exclusively for *Hilsa* fishing. *Hilsa* is caught along with many other fishes. It is used all-round the year except during the period when the rivers are flooded and violent, say July, August and September.

The length of the net is increased or decreased by attaching or detaching respectively more units of this net. One unit is about 12 feet long. The width of the net depends upon the depth of the river where it is used. Usually the width is about 8 to 10 feet. This net is kept in position in water by the pumpkin floats on the surface and weights at the bottom. It is operated at places where the river bed is more or less even. The number of crew depends on the length of the net used or in other words upon the area desired to be netted. Normally fifteen to twenty fishermen are engaged in it. The fishermen collect at a point on the bank of the river and hold one end of the net. The other end along with the entire length of the net is kept on a boat employed in fishing. Now a few fishermen go on rowing the boat along the bank of the river and simultaneously throwing the length of the net in water.

After having reached the desired distance the boat wheels round the area the fishermen wish to cover with the available length of the net and ultimately reach the point from where they had started. Now the crew divides into two teams of equal strength each holding one end of the net. Now both the ends are dragged out as a result of which fishes present in the area are mostly entrapped and are dragged out along with the net.

4. *Kuniar* (fig. 6).

This net was formerly not used for *Hilsa* fishing. From 1954, the bumper year for Hilsa, fishermen started operating this net for *Hilsa* fishing.

This is used in shallow waters where the fishes migrate along the current. The net is kept in inverted position and dipped and taken out of water wherever fish is expected. It is only a casual method of capturing *Hilsa*. Usually this is used for catching big carps etc. for which the operation is entirely different.

This is also operated single-handed.

5. *Lokani*

This is a triangular net tied to very light bamboo frame (fig. 5). This is also one of the casual methods of capturing *Hilsa* in shallow waters.

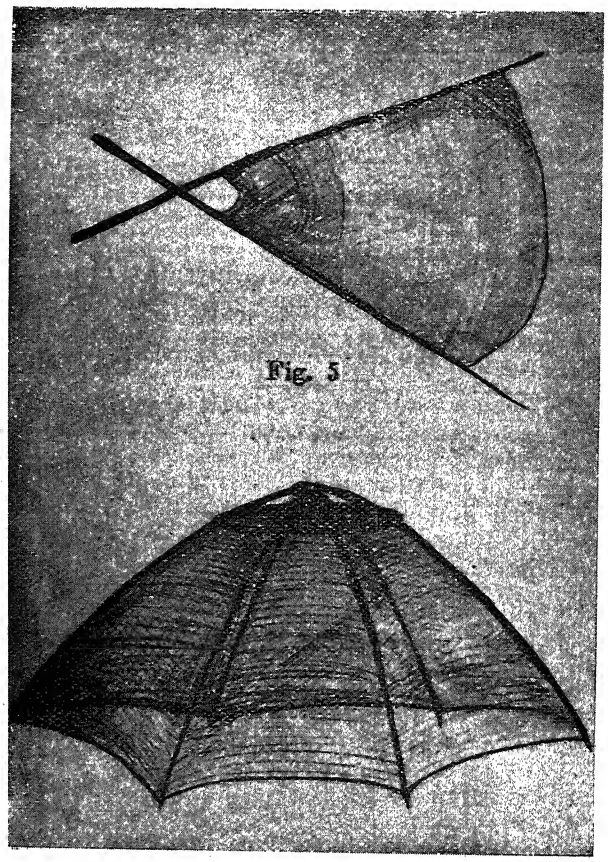


Fig. 5—Lokani net.

Fig. 6—Kuriar net.

A study of the gonad weight-body weight relationship (Graph 1) reveals that the seasonal cycle shows two peak seasons for the percentage of the gonad weight to body weight which are spread over October and March. Taking into account Pillay's statement (1954) it appears that such peak periods occur one month later and one month earlier respectively in the case of the Bengal Stock of Hilsa.

This shows that there are two breeding seasons viz., Autumn and Spring. The two spawning seasons last from August to November and March to April respectively. In October and March the fish spawns actively. The study of the seasenal progression of egg growth is in conformity with the above observation (Histograms 1-4).

The fish gives slightly pinkish appearance along the lateral line, fin bases and the snout during the breeding seasons which disappears after spawning. The colour on the snout only gets minimised.

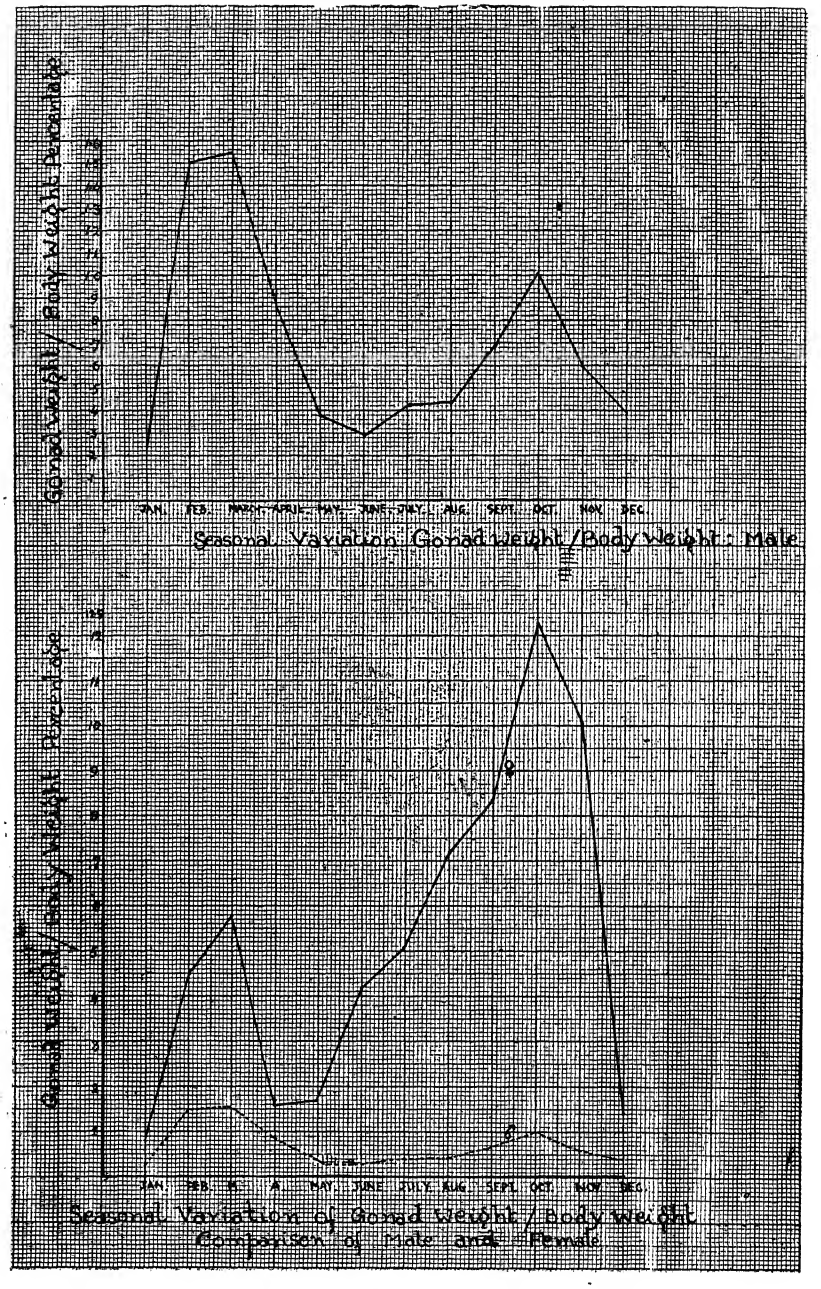
Hilsa breeds somewhere near Allahabad in the Ganga or in its tributaries as male and female specimens have been collected during breeding season with their milt and eggs oozing out of the vent respectively on slight pressure. This indicates that the fish have almost approached their spawning grounds. This fact, followed by the availability of juvenile *Hilsa* measuring from 50 m. m. to 70 m. m., from the last week of April to the end of June, strengthens the belief that *Hilsa* breeds near Allahabad. These juveniles probably represent the progeny of the fish which spawned in March and April. Likewise we should expect juveniles in January, February and March as the progeny of those having spawned in the preceding spawning season ; but juveniles are not caught during this period probably because the nets used for fishing have larger meshes through which the small fish manage to escape. During summer fine-meshed 'drag nets' are used and quite a good number of juvenile *Hilsa* are caught along with *Gadusia chapra*. Mixed lots of *Gadusia chapra* and young *Hilsa ilisha* are sold at very cheap rates (4-6 annas a seer).

The total number of Ova contained in a mature specimen weighing 1,163 gms. was estimated to be 1,168,622. From the fecundity data of 30 specimens plotted against the total weight (T. W.). Total length (T. L.) and forkal length (F. L.) the following regression equations and the coefficient of correlations (r) are found to obtain.

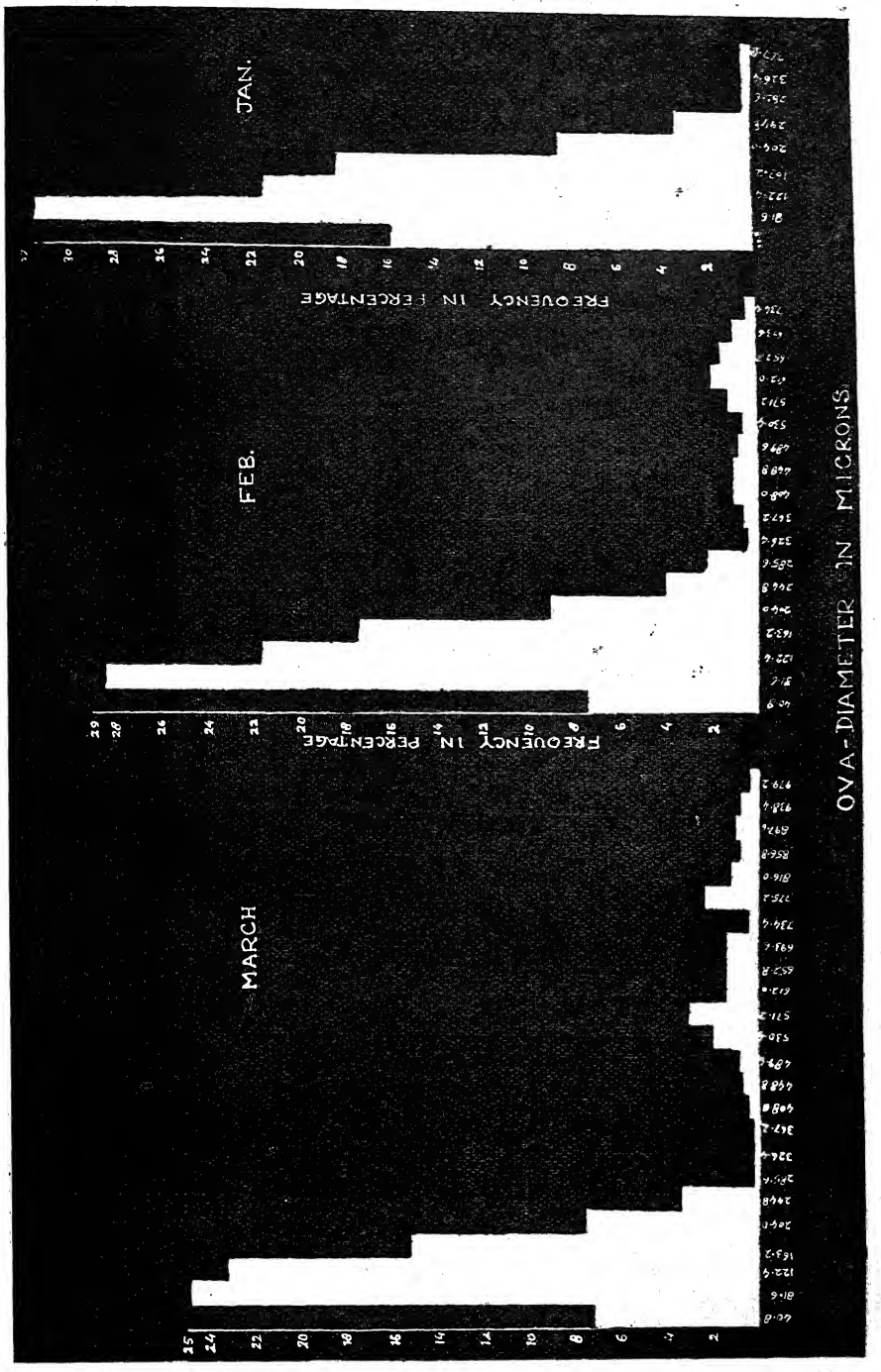
T. W.	$Y = 1{\cdot}08\ X_1 - 191$	$r = 0{\cdot}9513$
T. L.	$Y = 44298{\cdot}453\ X_2 - 1184820{\cdot}100$	$r = 0{\cdot}6086$
F. L.	$Y = 91{\cdot}9\ X_3 - 2705{\cdot}2$	$r = 1{\cdot}008$

The females are larger in size than the males. The largest adult female recorded in the present study measured 50·1 centimeters in length and 1332·18 gms. in weight and the smallest measured 14·6 centimenters and 36·0 gms. The largest adult male measured 44·7 cms. and 644·5 gms. and the smallest 15·0 cms. and 36·0 gms. A preponderance of males has always been observed and the ratio between the number of males and females can approximately be estimated at 2:1 respectively.

The fish does not have a single spawning act, but on the contray each individual fish spawns several times during the spawning season. This view is supported


Gonad weight / Body weight Percentage
JAN. FEB. MARCH APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Seasonal Variation: Gonad weight / Body weight : Male
Gonad weight / Body weight Percentage
JAN. FEB. M A MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Seasonal Variation of Gonad Weight / Body Weight
Comparison of Male and Female

GRAPH 1


JAN.
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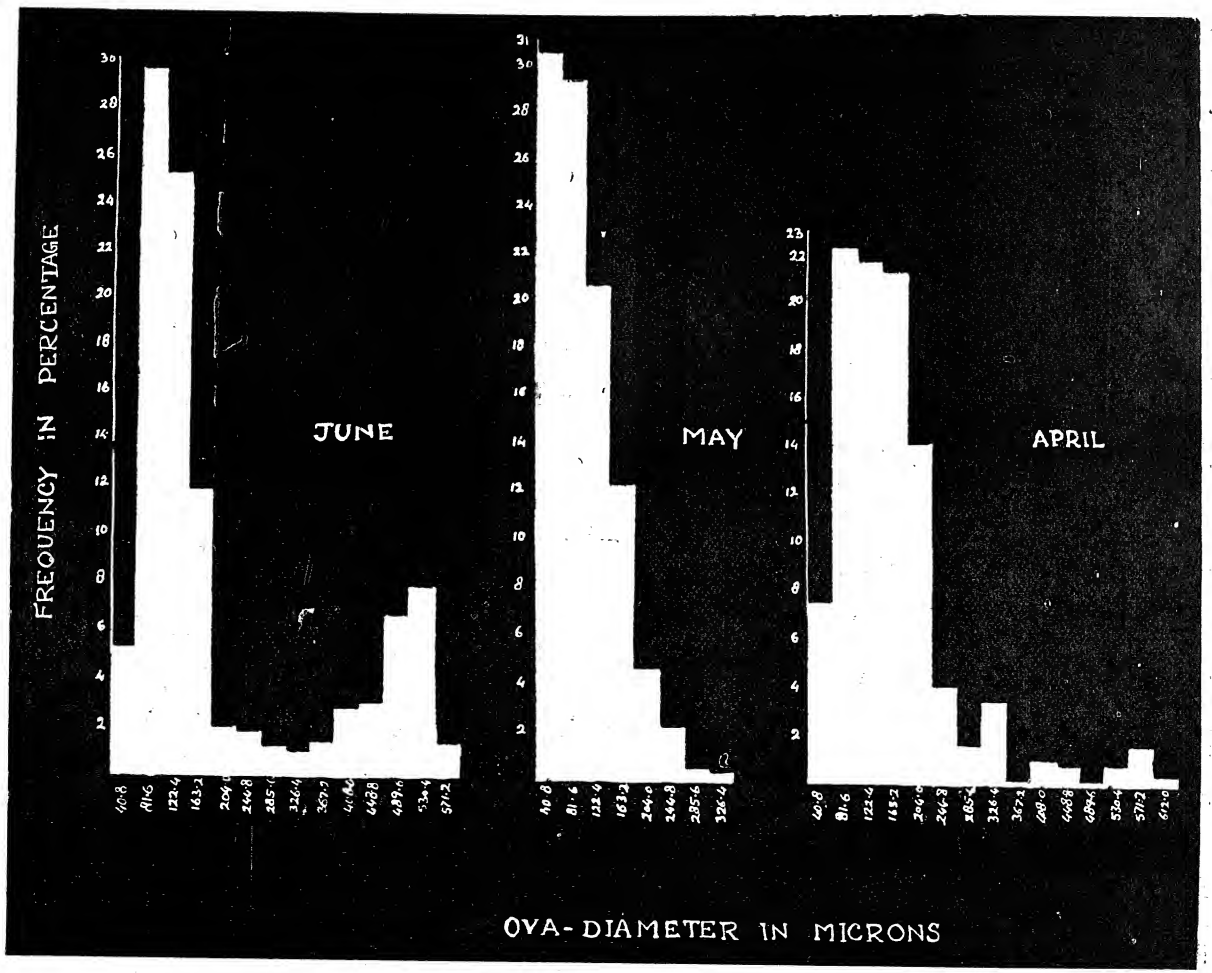
MARCH
FREQUENCY IN PERCENTAGE
OVA-DIAMETER IN MICRONS

Histogram 1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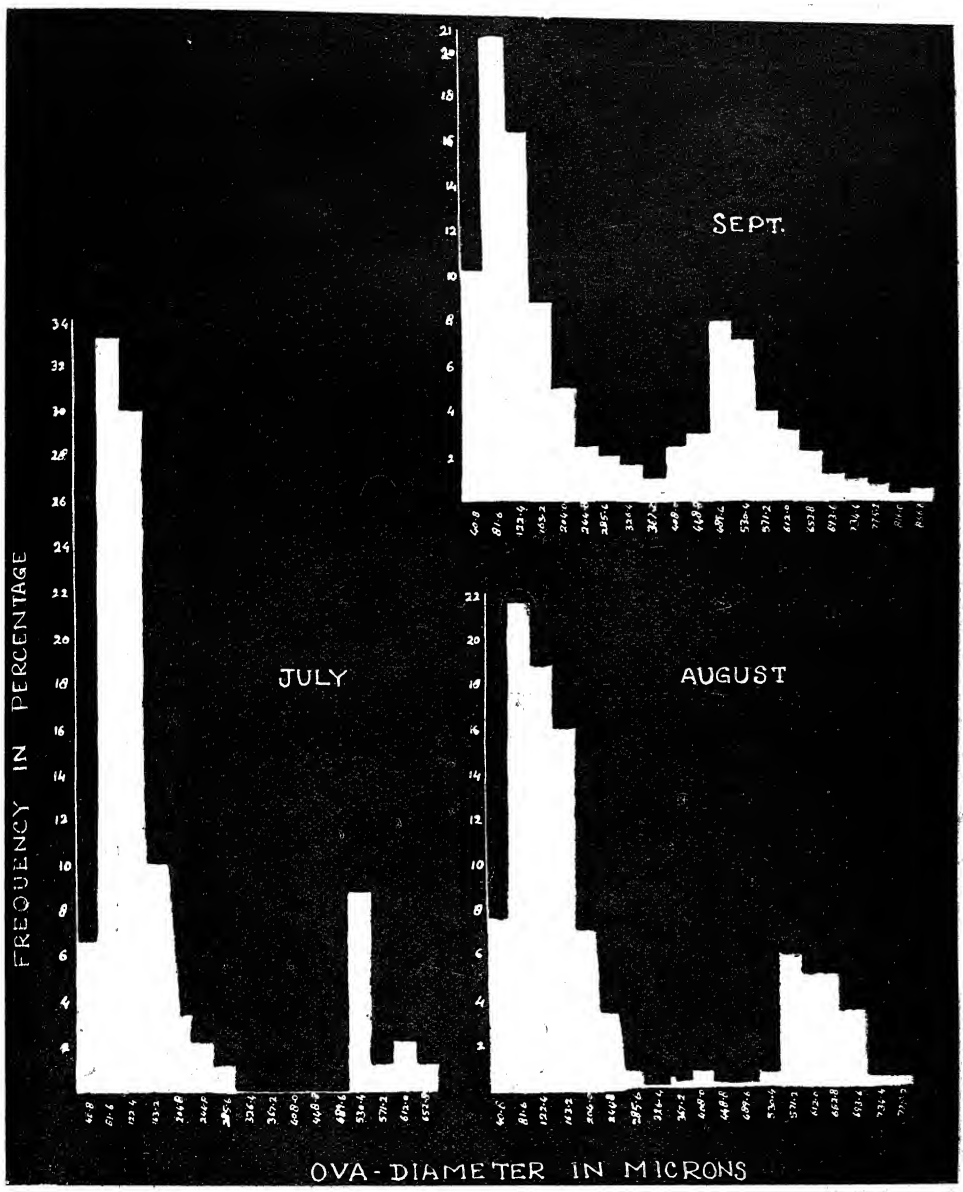
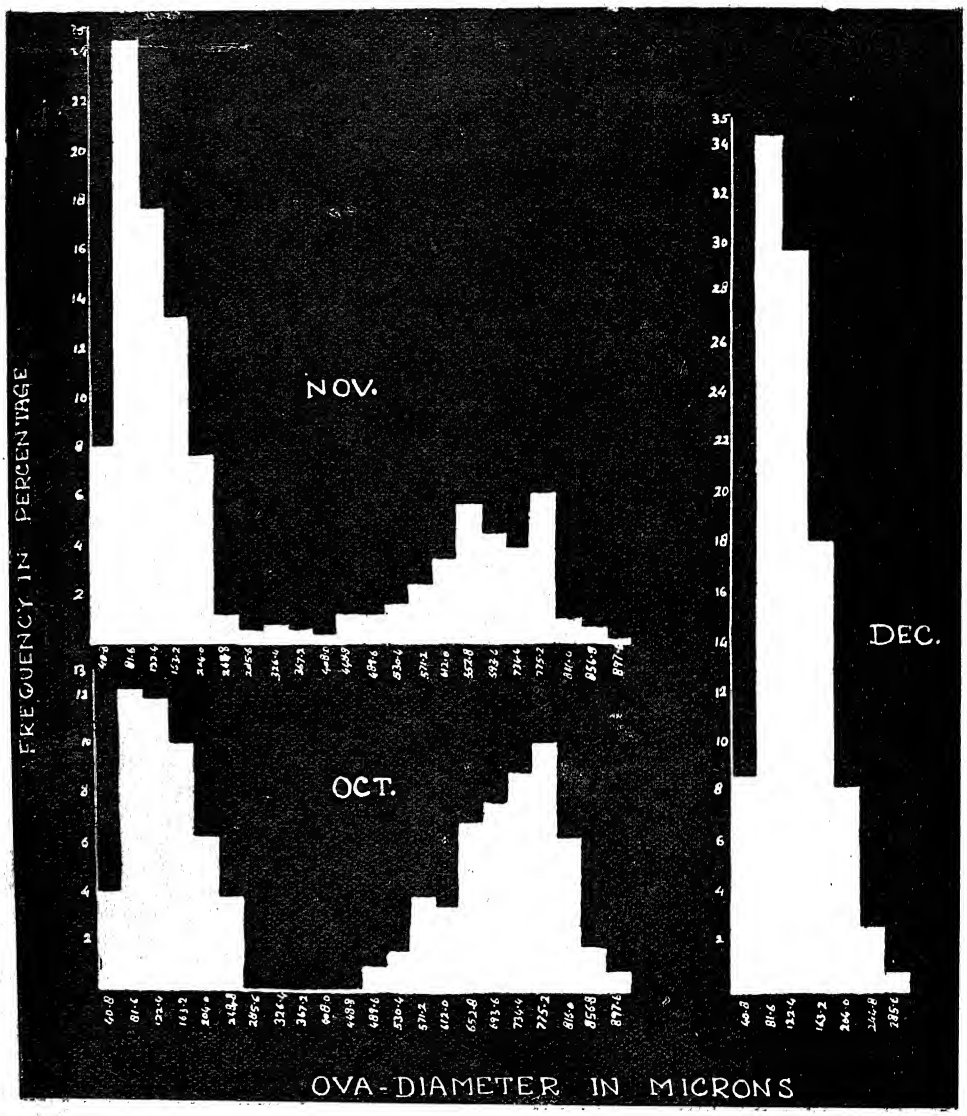
JUNE
MAY
APRIL
OVA-DIAMETER IN MICRONS

Histogram 2


SEPT.
JULY
AUGUST
FREQUENCY IN PERCENTAGE
OVA-DIAMETER IN MICRONS

Histogram 3


FREQUENCY IN PERCENTAGE
NOV.
OCT.
DEC.
OVA-DIAMETER IN MICRONS

Histogram 4

by the fact that very often males and females with partially spent gonads have been found. The *Hilsa* of Hooghly river also behaves in a similar manner (Pillay 1954).

The two lobes of Ovary are equal ly developed and when matured are pale yellow in colour. The testes lobes are however unequal as reported from *Hilsa* of Godawari river (Chacko and Ganpati 1949).

Hilsa is a plankton feeder. The gill rakers are setose, long, slender and closely set and are well adapted for straining small organisms from water. Its food comprises both of Zooplankton and phytoplankton. There are two periods of maximum feeding alternating with a stravation (Nov. Dec. and Jan.) and semistarvation (Feb. June and July) periods both in case of males and females. The maximum feeding periods in case of males are March and September, where-as in case of females it is March and August. Adult *Hilsa* is a surface feeder and is not ordinarily found to eat at depth below twelve feet. This fact is also corraborated with the study of their food. In the months of March, August and September when they actively feed, sand particles are not found at all in the stomach. In other months sand appears in the stomach with varying percentages. This appearance of sand is not because of their actual feeding habit but because of the fact that fishes after spawing are completely exhausted and are forced to go down near the bed of the river so that they may not be affected by the swift currents of the river. Thus it is because of their exhaustion that they are forced to feed at the bottom of the river.

The juveniles are voraceous feeder and the percentage of sand in their food is fairly high, which leads us to believe that they feed near the bottom. Hora (1938) also feels that the young *Hilsa* of Hooghly feed near the bottom.

It has been reported by Chacko and Ganpati (1949) and workers from other parts of India that sexually mature *Hilsa* abstains from feeding while ascending the river, but Allahabad *Hilsa* feeds during breeding periods. According to Bhimachar, the Indian representative at the Indo Pacific Fisheries Council (1955) the intensity of feeding increases among the spent *Hilsa* in the river Hooghly, but just contrary to it in case of Allahabad *Hilsa* immediately after spawning the feeding decreases.

ACKNOWLEDGEMENTS

I am grateful to the late Dr. D. R. Bhattacharya, Ph. D., D.Sc., F.N.I. for suggesting the problem and Dr. S. K. Dutta for his guidance. I have also to acknowledge thankfully the council of scientific and industrial research for financial assistance.

SUMMARY

1. *Hilsa ilisha* is found throughout the year in Ganga and its tributaries near Allahabad.

2. Allahabad *Hilsa* has two spawning season-one starting with the monsoon and lasting up to November and the other extending from February to April.

3. The number of males and females can approximately be estimated as 2:1 respectively.

4. The fish breed in the vicinity of Allahabad.

5. Sexually mature Hilsa feeds during breeding period and feeding decreases after spawning.

6. The nets used in Hilsafishing at Allahabad are Kamel, Bandal, Mahajal, Kuriar and Lokani.

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A NOTE ON PROBSTMAYRIA VIVIPARA(PROBSTMAYR, 1865) RANSOM, 1907 FROM AN INDIAN PONY WITH BRIEF REMARKS ON ITS SYSTEMATIC POSITION

By

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During studies on the nematode fauna of local equines, one of us (Rai) collected a large number of specimens of this minute pinworm from the ventral colon of a horse. This species, with its ovoviviparous females and the unique feature of its life cycle and method of spread, has been recorded from Egypt, Europe, South Africa and U. S. A. and an account of its anatomy has been given by Theiler (1923), Yorke and Maplestone (1926), Baylis (1929), Morgan and Hawkins (1953) and Lapage (1956). The specimens in our collection, on study from the material killed in hot 70% alcohol, have been found to agree essentially with some of these descriptions but a few points of difference in the accounts available in the literature are noticeable and, in the diagrams of Theiler (after Ransom, 1907) and by Yorke and Maplestone, the details of some structures do not appear to have been very clearly made out. It is, therefore, proposed to give below a brief and illustrated description of the salient features in the structures of this nematode which is, for the first time, being recorded from India.

DESCRIPTION

The worms, translucent in the living state, are minute, hair like, with long and tapering tails forming nearly 1/3rd of the total length of the body. The males are 1·8 – 2·0 m.m. and females 2·3 – 3·8 m.m. in length. The mouth, surrounded by a collar of 0·015 × 0·02 m m. in size, is formed by three prominent lips, each being divided into two parts. The mouth cavity, 0·016 m.m. in length, leads into a prominently cylindrical pharynx or vestibule of 0·05—0·07 m.m. in length and this is followed by an oesophagus which is divisible into two distinct parts—an anterior greatly elongated tubular portion, 0·3 m.m. long and with the nerve ring lying near its middle and a flask-shaped posterior part having a slightly curved neck of 0 09 m.m. length followed by the muscular bulb of 0·045 m.m. diameter. The excretory vesicle lies between the flask-shaped part of the oesophagus and the body wall and opens through an excretory pore. The intestine is well developed and tubular, beginning at about 0·5 m.m. distance from the anterior end it terminates at the anus which lies 0·95 – 1·15 m.m. distance from the posterior end. The female genital opening, situated just in front of the middle of the body length, leads through a short vagina into two short but wide uteri which continue through similarly small-sized oviducts into the slightly coiled but short ovaries. Uteri have been observed to possess eggs, mostly two in number but in different size and degree of development and the embryos that had hatched were seen lying coiled up inside it, the maximum number observed was upto three, and at this stage the size of the coiled developmental stage was highly advanced approximating the length of the adult worms. In male, the single tubular testis extends upto the anterior border of intestine and the two slightly curved spicules are nearly equal in size and measure 0·05 – 0·08 m.m. in length. There are only six pairs of postanal papillae.

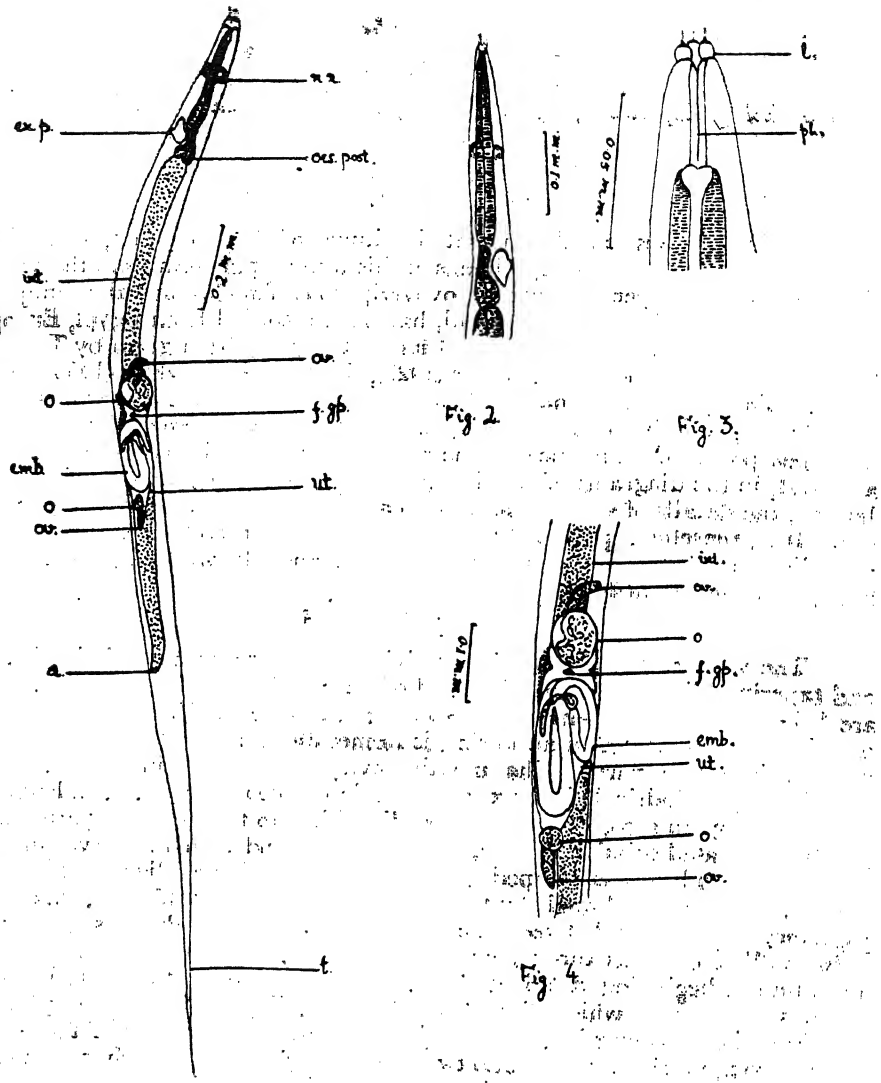

Fig. 2

Fig. 3.

Fig. 4

Fig. 1—Complete female worm.
Fig 2—Anterior end, oesophageal region.
Fig. 3—Anterior end, greatly enlarged.
Fig. 4—Part of female worm, in the region of genital opening, with a coiled hatched embryo and two developing ova.

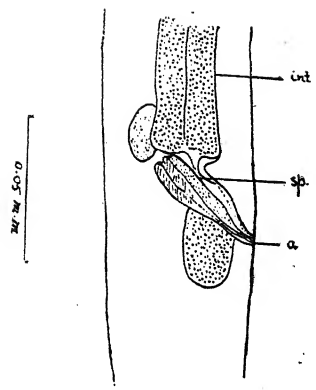

Fig. 5

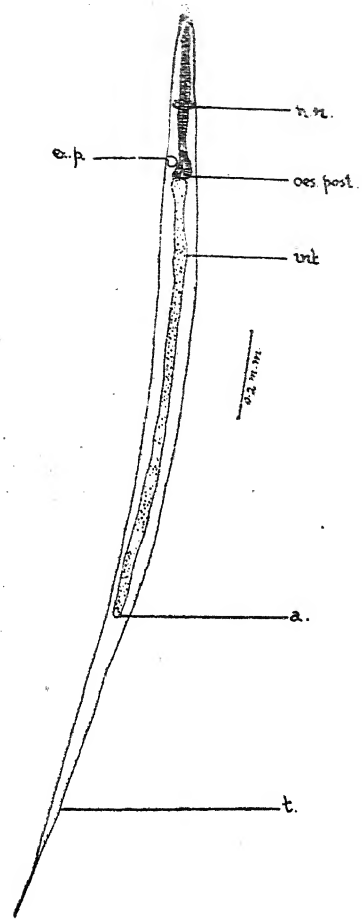

Fig. 6.

Fig. 5—Anal region of male with two spicules.
Fig. 6—Complete Larva (juvenile).

KEY TO LETTERING

a—anal opening, emb.—hatched embryo, ex. p.—excretory pore, f. gp. female genital pore, int.—intestine. l.—lip, n. r. nerve ring, o.—ovum, oes. ant.—oesophagus anterior portion, oes. post.—oesophagus posterior portion, ov.—ovary, ph.—pharynx or vestibule, sp.—spicule, t.—tail, ut.—uterus.

A perusal of the descriptions given by Theiler, and Yorke and Maplestone would show that in the matter of anal papillae there is a marked difference in the two accounts, the former mentions that there are four pairs of preanal and one pair of postanal papillae and according to latter, on the other hand, there are about six pairs of postanal papillae. We have observed that there are postanal papillae numbering six pairs, there being no prenal papillae. With regards to the position of the vulva, Theiler described it as being half way between the two body extremities while, according to Yorke and Maplestone, its position is near the middle of the body. In our study of the specimens, the position is really a little in front of the middle of the body.

REMARKS

Theiler, after reviewing the systematic position, assigned this pinworm, originally described by Probstmayr (1865) as *Oxyuris vivipara*, to the family Anguillulidae Dujardin, 1845 of the superfamily Ascaroidea Raillet and Henry, 1915. Subsequently, conflicting views have been held with regard to its clasification. Yorke and Maplestone assigned it to the sub-family Oxysomatiinae (Railliet, 1916) of Oxyuridae (Cobbold, 1864) under the order Oxyuroidea (Railliet, 1916) and Baylis included it under Kathlaniidae (Travassos, 1918) of the order Ascaroidea. Skryabin and Schikhobalova (1951), in their reconstruction of the classification of nematodes of Oxyurata Skryabin 1923, have created a separate sub-family Probstmayriinae under Cosmociriidae of a new superfamily Cosmocercoidea. Hyman, in the treatment of order Oxyuroidea, included this species under family Atractidae Travassos, 1919, and this family assignment has been followed by Morgan and Hawkins under the superfamily Oxyuroidea.

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EFFECT OF SOME MODERN ORGANIC INSECTICIDES ON TERMITE DAMAGE IN WHEAT CROP

By

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INTRODUCTION

Termites constitute a serious menace to living vegetation throughout the tropical and sub-tropical countries of the world. Particular mention may be made of such agricultural crops as wheat, sugarcane, groundnut, cotton etc., which are subjected to severe infestation in the Indian Union.

The control of termites in the field is one of the most difficult and baffling problems facing an economic entomologist today due to their peculiar habit of nesting underground. This is evident from the results obtained in Australia by Mungomery (1948), who found 10% BHC at as high a rate as 40 lbs/acre to be ineffective against *Mastotermes darwiniensis* Frogg. infesting sugarcane.

It is generally accepted today that termites are the only major instect pests of wheat taking heavy toll of the crop year after year in the entire wheat growing tracts of the Indian Union. Their depredations, of course, depend on the physico-chemical nature of the soil and the ecological factors. Husain (1935) found *Microtermes obesi* Holmgr. as the most serious pest sometimes causing heavy losses to germinating wheat particularly under conditions of high temperature and low moisture in the Punjab and U. P. during October and November. According to him, a modest estimate of the average annual destruction of the total crop by termites is about 6% and occasionally 25%. Moreover, these tiny sub-terranean insects are in a position to damage wheat crop during different stages of its growth.

There is very little published record of experimental data regarding the use of modern organic insecticides against termites infesting wheat. Recently Narayanan and Lal (1952) conducted field experiments in wheat plots which were each 1/160 of an acre. In these experiments wheat seeds were treated before sowing or the soil was treated before and after sowing, with different formulations of pp' DDT, BHC or dithane. Inspite of their data being significant the results obtained can be considered to be only of a preliminary nature as they found that the termite infestation was *by chance* very meagre in the control plots also.

During the course of the present investigation, field trials were conducted from 1953 to 1955 to study the effect of dosages upto 20 lbs/acre of some modern organic insecticides used either alone or as mixtures on termite damage in wheat crop.

MATERIAL AND METHOD

The insecticides used were (*i*) DDT-techical (90% p,p' isomer) supplied by Messrs Geigy Insecticides Ltd., Bombay, (*ii*) BHC-technical (13% gamma isomer) supplied by Messrs Imperial Chemical Industries Ltd., Bombay, (*iii*) Dieldrin-technical (9:% purity) supplied by Burmah Shell Ltd., Bombay, and (*iv*) Toxaphene-technical chlorinated [Active ingredients : camphene 40% (chlorine content 67% to 69.)] supplied by Hardcastle, Waud and Co. Ltd., Calcutta.

All the insecticides used were in the form of dust.

In the first year, insecticidal trials against termites infesting wheat were conducted at the top block '4E' 'South', while in the second year, at the top block '4C' 'South' of the farm of the Agronomy Division of the Indian Agricultural Research Institute, New Delhi. The incidence of termites in the plots selected for the experiments was heavier than any other plot in that area.

The experiment was laid out in 54 equal sized plots during the first season. The size of each plot was 30'×22'. The insecticides experimented upon were (*i*) a mixture of DDT and BHC dust (50:50) and (*ii*) toxaphene dust, with four dosages of each treatment, *viz.* 5, 10, 15, and 20 lbs per acre. Thus there were nine treatments including control, replicated six times in randomized blocks. In the second season the experiment was conducted in 44 equal sized plots. The size of each plot was 36'×23'. The insecticides tried were (*i*) a mixture of DDT and BHC dust (50:50) used @ 5, 10, 15, and 20 lbs/acre ; (*ii*) a mixture of DDT and toxaphene dust (50:50) and (*iii*) Flake dieldrin dust, the latter two treatments being used @ 5, 10 and 15 lbs/acre. Thus there were eleven treatments including control, replicated four times in randomized blocks.

Each insecticide was broadcast in different plots before sowing according to a randomized plan. The crop was harvested without any further insecticidal treatment. Wheat variety NP 710 was sown @ one maund per acre.

OBSERVATIONS

After a fortnight from the date of sowing, the germination was found to be satisfactory in all the plots. The number of germinated plants and those damaged by termites were counted in each plot. However, during the second season due to the difficulty in counting all the plants, only 7 rows were selected at random out of 21 rows in each plot. Both the healthy and the damaged plants were counted in all the 7 rows and the percentage of damage was calculated for each plot.

In the first season, the tillers of wheat plants were counted in 5% of the plants taken at random in six fixed areas of each plot. During the second season, the tillers were counted in 10% of the plants in seven random rows in each plot.

The relevant data for both years with the statistical analysis are given in Tables I to III.

Results of first year's experiment (1953-54) on the effecet of various insecticides against termite damage in wheat.

TABLE I

Total number of plants damaged by termites in each plot.

(a) Mixtures	Log (Av. No. of plants damaged)	Av. No. of plants damgaed
M_1	2·11	128·8
M_2	2·34	218·8

S. Em.	± 0·0585	C. D. at 5% = 0·167 C. D. at 1% = 0·224

'F' significant at 1%

(b) Doses	Log (Av. No. of plants damaged)	Av. No. of plants damaged
5 lbs	2·464	291·1
15 lbs	2·223	167·1
10 lbs	2·210	162·2
20 lbs	1·989	97·5
Control	3·216	1644·0

S. Em for doses	± 0·0830	C. D. at 5% to compare doses : 0·237 C. D. at 1% to compare doses : 0·317
S. Em for control	± 0·117	C. D. at 5% for control Vs. doses : 0·334 C. D. at 1% for contorl Vs. doses : 0·447

'F' signficant at 1%.

TABLE II

Percent plants damaged by termites in each plot.

(a) Insecticides (mixture)	Av. % plants.
M_2	5·77
	'F' not significant
M_1	4·25

S. Em ± 0·728

(b) Doses	Av. % plants.
5 lbs	8·53
15 lbs	4·43
10 lbs	3·80
20 lbs	3·27
Control	34·19

S. Em for doses	± 1·029
C. D. at 5% to compare doses	2·95
C. D. at 1% to compare doses	3·96
S. Em for control	± 1·456
C. D. at 5% for control Vs. doses	4·18
C. D. at 1% for control Vs. doses	5·61

'F' significant at 1%.

M_1=mixture of DDT and BHC dust (50:50).
M_2=Toxaphene dust.

Results of second year's experiment (1954-55) on the effect of various insecticides against termite damage in wheat.

TABLE III

Treatments	Average number of germinated plants in 7 random rows (4 replications)	Treatments	Average number of plants damaged in 7 random rows (4 replications)	Treatments	Average percentage damage (4 replications)	Treatments	Average yield of grain with husk (4 replications).	Treatments	Average yield of grain. (4 replications).
a	3043·3	k	759·2	k	38·4	j	93·5 lbs.	j	27·9 lbs.
b	3011·8	e	552·8	e	22·8	b	88·7 lbs.	i	25·8 lbs.
i	2951·5	f	356·0	f	13·2	h	88·0 lbs.	c	25·5 lbs.
j	2852·0	a	336·3	a	11·1	i	87·3 lbs.	g	25·2 lbs.
g	2812·3	i	181·3	h	7·1	c, g	86·8 lbs.	b	24·5 lbs.
f	2790·0	h	179·5	g	6·6	d	86·5 lbs.	h	24·4 lbs.
c	2766·8	g	179·0	i	5·8	f	86·2 lbs.	f	23·8 lbs.
h	2705·5	d	153·0	d	5·6	a	82·3 lbs.	d	23·7 lbs.
d	2686·8	b	136·5	b	4·5	e	67·7 lbs.	a	21·5 lbs.
e	2344·3	c	120·5	c	4·1	k	52·5 lbs.	e	17·9 lbs.
k	1972·5	j	54·2	j	2·0			k	17·1 lbs.
S. Em ± 184·6		S. Em ± 82·7		S. Em ± 3·5		S. Em. ± 5·8		S. Em ± 2·1	
C. D. at 5% 533·0		C. D. at 5% 238·8		C. D. at 5% 10·0		C. D. at 5% 16·7		C. D. at 5% 5·9	
		C. D at 1% 321·6		C. D. at 1% 13·5		C. D. at 1% 22·5			
'F' significant at 5%		'F' significant at 1%		'F' significant at 1%		'F' significant at 1%		'F' significant at 5%.	

a : mixture of DDT and BHC (50:50) applied @ 5 lbs./acre.
b : „ „ „ „ @ 10 lbs./acre.
c : „ „ „ „ @ 15 lbs./acre.
d : „ „ „ „ @ 20 lbs./acre.
e : mixture of DDT and toxaphene (50:50) applied @ 5 lbs./acre.
f : do. @ 10 lbs./acre.
g : do. @ 15 lbs./acre.
h : Dieldrin dust applied @ 5 lbs./acre.
: do. do. @ 10 lbs./acre.
j : do. do. @ 15 lbs./acre.
k : Control (untreated).

Mostly those plants which were clustered together were damaged by termites with the result that the vegetation in the infested plots became scanty and sparse. This observation led to the laying out of an experiment in 1954-55 to study the effect of different seed rates on the infestation and damage in wheat by termites. As recorded earlier (Fletcher, 1917) the plants bearing ears were found damaged so that either the seeds were not formed at all in the ears or if at all the seed formation took place, they were shrivelled. The wheat grains in the spikelets of the harvested plants touching the ground were also observed to be nibbled by the termites. *Microtermes obesi* Holmgr. was mainly responsible for the damage of the plants.

DISCUSSION

The data of first year's experiment were statistically analysed for six factors *viz.* (*i*) total number of plants germinated in each plot (*ii*) total number of plants damaged in each plot (*iii*) percentage of damaged plants in each plot (*iv*) Number of tillers at 5% random plants (*v*) yield of grain with husk and (*vi*) yield of grain without husk.

(*a*) Analysis of the data on total number of plants damaged by termites in each plot showed highly singnificant differences among the dosages and also between the treatments. The interaction between dosages and treatments was, however, not significant. Damage in the control plots was significantly higher than in the plots treated with different dosages. With regard to dosages least damage was recorded with 20 lbs/acre but it did not differ significantly from the damage with dosages of 10 and 15 lbs/acre. The mixture of DDT and BHC (50:50) proved significantly better than toxaphene dust.

(*b*) As regards percentage damage of plants in each plot, the differences among the dosages were found to be highly significant. The differences in the treatments and the interaction were not significant. The percentage damage in the control plots was much too high as compared to other treatments. With regard to dosages the results were exactly similar to those obtained under total number of plants damaged discussed in (*a*) above.

The statistical analysis of all the factors showed that the various tratments were effective in reducing the damage but there was no significant difference in germination, tillering or yield with regard to the treatment. This can be explained on the basis of wide variation in number of germinated plants in different treatments. Since the mixture of DDT and BHC (50:50) proved significantly better than toxaphene dust, the experiment was repeated for the second season. Equal weight of wheat grains was sown in each row in order to ensure maximum uniformity in the number of germinated plants.

The second year's statistically analysed data on the six factors are discussed below :—

(*i*) Analysis of the data on total number of plants germinated in each plot showed significant difference at 5% level between the control and treatments, except in the case of a mixture of DDT and toxaphene dust (50:50) used @ 5 lbs/acre which did not differ significantly from the control. The various insecticides irrespective of their dosages did not show any significant difference among themselves. However, the number of plants germinated were more in the plots treated with a mixture of DDT and BHC (50:50) used @ 5 and 10 lbs/acre.

(*ii*) Analysis of the data on the total number of plants damaged by termites in each plot showed highly significant difference at 1% level between the control and the treatments except in the mixture of DDT and toxaphene dust used @ 5 lbs/acre, which did not differ from the control. Plots treated with dieldrin showed significantly lesser number of plants damaged than with a mixture of DDT and toxaphene. The minimum number of plants damaged was found in the plots treated with dieldrin dust @ 15 lbs/acre. The maximum number of plants damaged was in the control plots and also in those treated with DDT and toxaphene mixture used @ 5 lbs/acre.

(*iii*) As regards percentage damage of plants by termites, there was highly significant difference at 1% level between the control and the treatments, the control showing the maxium percentage damage. After control, DDT and toxaphene used @ 5 and 10 lbs/acre showed the maximum percentage damage. The minimum percentage damage was recorded with 15 lbs/acre dieldrin. The position of DDT and BHC mixture used at the rate of 10 and 15 lbs/acre was slightly higher than the minimum.

(*iv*) In the case of tillers no significant difference was indicated either for various treatments or the dosages as compared to control.

(*v*) Analysis of the data on yield of grain with straw husk showed highly significant difference at 1% level among the control and the treatments except in the case of DDT and toxaphene mixture used @ 5 lbs/acre. The minimum yield was recorded in the control and in the plots treated with DDT and toxaphene mixture used @ 5 lbs/acre. The maximum yield was obtained with a treatment of 15 lbs/acre dieldirn followed by DDT and BHC mixture used @ 10 lbs/acre. No significant difference was found in the three types of insecticides, irrespective of various dosages.

(*vi*) Analysis of the data on yield of grain showed highly significant difference @ 5% level between (*i*) control, DDT and toxaphene mixture @ 5 lbs/acre, DDT and BHC @ 5 lbs/acre, and (*ii*) the rest of the treatments. The minimum yield was obtained in the control while the maximum was with dieldrin used @ 15 lbs/acre. Irrespective of the dosages the difference between various insecticides was not significant.

It will thus be seen that the treatments showed significantly less damage to the plants by termites, more germination and higher yield but the various insecticides did not differ significantly in tillering from the control. Dieldrin and a mixture of DDT and BHC (50:50) were found to be superior to DDT and toxaphene mixture (50:50) in respect of percentage damage and yield. In majority of cases toxaphene and DDT mixture used @ 5 lbs/acre did not differ from the control.

SUMMARY AND CONCLUSIONS

The results of the field experiments conducted during 1953-1955 on the effect of technical grade insecticides *viz.* DDT, BHC, toxaphene and dieldrin dusts used either alone or in combination upto 20 lbs/acre against termite damage in wheat plants have been reported. The insecticides were applied in the soil only once before sowing.

The insecticides used in the first year's experiment were (*i*) DDT and BHC dust mixture (50:50) and (*ii*) toxaphene dust, with four dosages of each treatment

viz. 5, 10, 15 and 20 lbs/acre. A mixture of DDT and BHC (50:50) used @ 10, 15 and 20 lbs/acre was quite effective in reducing the damage but there was no significant difference in germination, tillering or yield with regard to different treatments.

The following combinations of insecticides were tried in the second year : (*i*) a dust mixture of DDT and BHC (50:50) applied @ 5, 10, 15 and 20 lbs/acre, (*ii*) a dust mixture of DDT and toxaphene (50:50) and (*iii*) technical flake dieldrin dust applied @ 5, 10 and 15 lbs/acre separately before sowing.

The statistical analysis of the data for the second year showed that the treatments indicated significantly less damage to the plants by termites, more germination and higher yield but the various insecticides did not differ significantly in tillering from the control. Treatment with dieldrin and DDT and BHC mixture (50:50) were superior to DDT and toxaphene mixture (50:50) in respect of pescentage damage and yield. In majority of cases toxaphene and DDT mixture used @ 5 lbs/acre did not differ from the control.

ACKNOWLEDGEMENT

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CERTAIN INTERESTING ABNORMALITIES IN THE GONADS OF HILSA ILISHA (HAMILTON)

By

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Norman (1951) in his book "History of Fishes" has described that occasionally individuals are found in which both male and female reproductive organs are fully developed. A number of workers have reported the occurrence of juvenile hermaphroditism in teleosts. Grassi (1919) reported juvenile hermaphroditism in eel which was confirmed by D'Ancona (1924). Mrsic (1923) noted similar case in rainbow trout (Salmo fario). Essenberg (1923 and 1926) observed sex reversal in *Xiphophorus helleri* which according to Hann (1927) might be taken as evidence of an hermaphroditic condition.

Mac Leod (1881) was the first to report about retained hermaphroditism in the adults in *Serranus* and in the Sparidae. Later on, occasional cases of adut hermaphroditism have been reported in other species (Smith, 1882, Howes 1891, etc.). Recently Chacko and Krishnamurti (1949) have made a passing remark on the occurrence of hermaphroditism in a specimen of *Hilsa ilisha* caught by them. The author, while working on the histology of the gonads of *Hilsa ilisha* came across a preparation clearly exhibiting growing young oocytes and spermatogenic stages side by side in the same gonad (Fig. 1). This has led him to believe that there occur casual cases of hermaphroditism in *Hilsa ilisha.*

While conducting the present study the author has examined near about one thousand specimens and has come across a number of rare and interesting abnormalities in *Hilsa ilisha.*

On 8th October, 1954. a female specimen of *Hilsa ilisha* was collected from the Ganga in which there was only one ovary instead of a pair of ovaries (Fig. 2). The measurements of the fish were :—Total length—47 cm, depth of body 12·5 cm, total weight—1,158·3 gm, and the weight and the volume of the ovary was 239·8 gm. and 245 c.c., respectively. The ovary was found to be in the sixth stage of maturity. Fecundity of the ovary taken out was found to be containing 1,163,750 eggs. The diameter of the eggs ranged from 0·66 mm. to 0·8 mm.

The following table gives a comparative account of the abnormal and some normal cases.

There can be two alternative possibilities for such an abnormality. The first is that the two ovaries might have developed, but one of them degenerated at a later stage of development ; and the second is that both the ovaries might have developed and got fused together. The author feels that in the present case the latter seems to be more plausible, because the abnormal single ovary is *at par* in every respect with that of the two normal ovaries. To substantiate this possibility, the study of blood supply was taken up. It was found that the two gonadal arteries arising from the dorsal aorta supplied the dorsal and ventral sides of the fused ovary, which confirms the view that the two ovaries must have fused together at some stage of development.

Fig. 1.

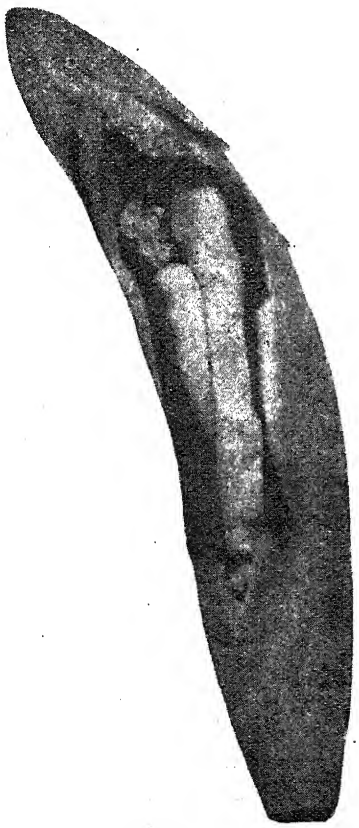

Fig. 2.

Fig. 3

Date of Collection	Total Length of Fish	Depth of the body	Total weight	Weight of ovary or ovaries	Volume of ovary or ovaries	Fecundity	Condition of ovaries	Gut Contents	Remarks
8-10-54	47 cm.	12·5 cm.	1158·3 gm.	239·8 gm.	245 cc.	1163750	Single Ovary 6th stage of maturity.	Traces of vegetable matter	Abnormal case
16-10-54	40 cm.	13·1 cm.	1029·6 gm.	222·2 gm.	214 cc.	1080375	Paired ovary 5th* stage of maturity	do.	Normal case.
28-10-54	43 cm.	12·1 cm.	1025 gm.	141·4 gm.	135 cc.	891700	do.	Empty	do.
2·11-54	45·3 cm.	10·7 cm.	964·4 gm.	239 gm.	231 cc.	1287825	Paired Ovary, 6th stage of maturity.	Vegetable matter in traces only.	do.
13-11-54	43·7 cm.	11·4 cm.	935 gm.	196 gm.	180 cc.	445950	do.	do.	do

*Fifth stage of the maturity of ovary means that the ovary is fully mature but the eggs are not oozing out from the vent.

A case of partial fusion of the two ovaries was also noted on 14th November, 1954, when a fish was caught in which both the ovaries were present and were fully developed but posteriorly the two ovaries were blended together, while anteriorly they were free as in the normal case. The measurements of the fish were :—Total length 41 cm., body depth 11·5 cm., total weight 1,015 gm., weight of ovaries 138·5 gm., volume of ovaries 131 c.c., and fecundity 986,360. The ovaries were in the fifth stage of maturity.

Another interesting abnormality was detected in a male *Hilsa* collected on the 7th April, 1955. In this case, the anterior three-fourths of the testes were free, and the remaining one-fourth were joined in the middle, the anterior halves were completely fused together and the posterior halves were again free (Fig. 3). The testes were in the fifth stage of maturity. The measurement of the fish were : Total length—25 cm., body depth—5·7 cm., total weight...132 gms.

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A NEW BLOOD FLUKE CERCARIA FROM THE INDIAN SNAIL LINNAEA LUTEOLA

By

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(Received on January 21, 1958)

This paper gives an account of the morphology and relationship of a new species of blood fluke cercaria obtained from the snail *Limnaea luteola* (Lamarck) brought for examination at the Zoology Department of the University of Allahabad in December 1950, from a small pond at Allengunj, Allahabad. Out of the thirty snails examined only one snail was found infected with this cecaria, the percentage of infection being only 3%. This cecaria was again obtained in March, 1951 from the same species of snail brought from Sewait in Allahabad district. The percentage of infection this time was 2·5%.

CERCARIA SEWATII n. sp.

The cercariae are quite large and can be seen with the naked eye. They come out of the snail in large numbers and their behaviour is very much similar to that of schistosome cercariae. The emerged cercariae sink slowly in water with the body downwards and furcae upwards, the tail stem being held generally straight and the furcae sufficiently apart so as to enclose an angle of a little less than 90°. After sinking to a short depth the larva darts all of a sudden and then begins to swim for a short distance in different directions. It then abruptly stops its swimming movements and again starts sinking slowly in water. The swimming movements are performed by vigorous lashing of the tail with the body or tail directed forwards. The locomotion is mostly irregular and very little in straight lines.

Under the coverglass the cercaria shows looping movements which change according to the pressure exerted on it. The inch worm locmotion was observed under the cover glass. At first the body extends and the anterior end takes a firm hold of the substratum. Then with the contraction of the body its posterior part is brought near the anterior end, so that the laterally protruded ventral sucker takes firm hold of the substratum beside the anterior organ. The attachment of the latter is now released and this series of movements is again repeated. While contraction and expansion of the body is thus going on, intermittent lashing of the tail can also be observed. Due to the protrusion of the ventral sucker the animal lies on its sides so that the lateral view is the one which is usually obtained, the frontal mount being obtained with difficulty.

The cercariae remain alive in tap water at room temperature for more than 48 hours. The dead cercariae almost always had their ventral suckers protruded and a good number of them also had their tail stem detached from the body.

The cercaria is quite transparent possessing spindle shaped body with its anterior part in front of the protruding ventral sucker tapering gradually to a bluntly rounded end and the posterior part slightly constricted just in front of the point of junction with the tail stem. Due to the contraction and expansion of its

body there is a great variation in the size and shape of the cercaria in the living condition. In the extended condition, the body is twice as long as it is in the contracted condition and its breadth is equal to that of the tailstem except in the region of the anterior organ and the ventral sucker where it is slightly broader. During extension the outlines of the head gland and penetration glands are sharply marked out along with the thick ducts of the latter, particularly in the region of the anterior organ. The sizes under various conditions are as follows :

Living specimens.

State of maximum extension—Body—0·35-0·45 ×·039-·041 mm.
Tailstem—0·35-0·37 ×·02 mm.
Furcae—0·25 mm long.

State of maximum contraction—Body-0 14-0·2 ×0·075 mm.
Tailstem-0·25 × 0·05 mm.
Furcae-0·14 mm Long.

Dead specimens

Specimens fixed in 10% formalin. Body-0·34-0·41 ×·042-0·045 mm.
Tailstem-0·33-0·035 mm.
Furcae-0·18-0·21 mm long.

Specimens which died a natural death. Body-0·288 × ·06 mm.
Tailstem-0·31 × 0·045 mm.
Furcae. 0·21 mm long.

The spines are present all over the body, the tail stem and the furcae. The tail stem is attached to the body at its posterior end and has a width of 0·045 mm. which is equal to that of the body in its hinder most region. The width of the tailstem gradually diminishes towards its end where it measures 0·036 mm. The furcae are some-what laterally compressed and show slight constrictions at their bases. Each furcae measures 0·025-0·027 mm. in breadth in the proximal region but the breadth becomes greatly reduced in the distal region which ends in a bulbous expansion. The finfolds begin at ¼th distance of the length of the furca from its point of origin. The anterior organ is large and varies from pyriform to elongated oval shape. It occupies anterior third part of the body and measures ·072 × ·039 mm. in prepared mounts and ·091 × ·062 mm in the living condition. The movements of contraction and expansion of the anterior organ may take place independently of the body movements. The anterior organ consists of two easily distinguishable parts ; the larger anterior part of 0·066 × 0·045 mm. size which is thinner and often outpushed beyond the anterior end of the body and the smaller thicker muscular posterior part of roughly triangular shape with the blunt apex directed backwards and of 0·027 × 0·03 mm size. The conspicuous head gland opens at the anterior end and has coarsely granular cytoplasm and measures 0·084 mm. long in an entire mount of a well extended specimen. With movements of the anterior organ, the head gland also moves and its shape and size continue changing.

The prominent ventral sucker, 0·024 mm. in diameter lies at 0·12—0·17 mm distance from the anterior end. In the larva lying on its sides the ventral sucker

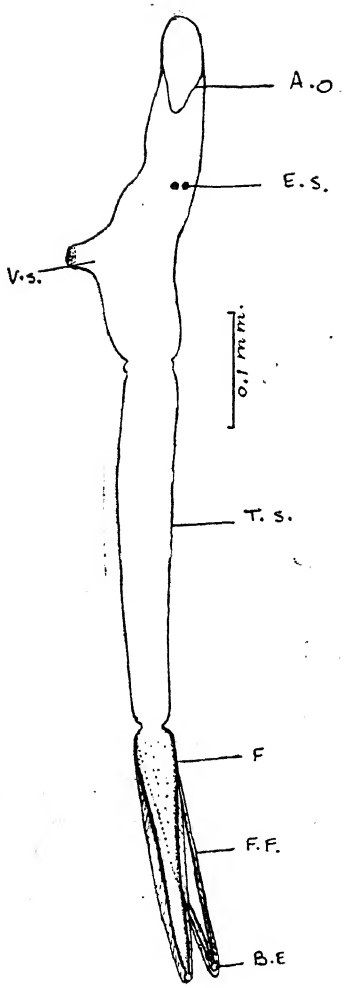

Fig. 1. Semilateral view of *C. Sewatii.*

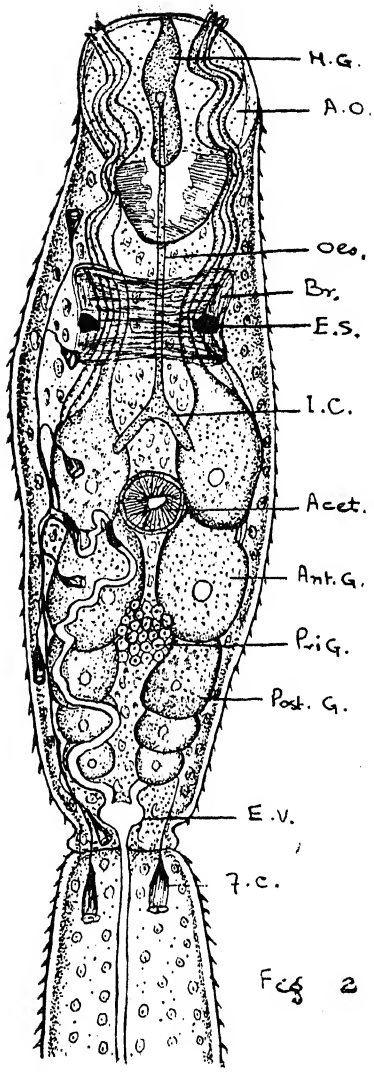

Fig. 2. Ventral view of *C. Sewatii.*

invariably protroudes out and projects slightly backwards. Two sets of muscle bands connected with the ventral sucker have been observed. The powerful bands of musele fibres radiating from the proximal region of the ventral sucker are attached to the dorsal side of the body and the circular band of muscle fibres is clearly seen around its distal part.

The compound eyespots composed of a large number of small dark brown granules and a lens situated at a distance of 0·09-0·12 mm. from the anterior end in entire mounts measure 0·006-0·009 mm. across. They are separated from each other by an intervening distance of 0·03 mm. and from the body wall by 0·021-0·027 mm. distance.

The mouth opening is small lying subterminally on the ventral side near the anterior end. The pharynx is absent. The capillary oesophagus measures 0·085-0·097 mm. in length as it passes backwards through the anterior organ. It bifurcates into two short caeca at about half the distance between the acetabulum and eye spots. The caeca are short and straight and no not reach upto the ventral sucker. The intestine is usually not seen in entire mounts. The nervous system is in the form of a bilobed mass lying anterior to the eye spots.

The conspicuous penetration glands occupy almost the entire region of the body behind the eyespots. They occur in two sets of which the anterior one is more prominent and consists of two pairs of circum-acetabular gland cells. The most anterior pair of this set is slightly larger than the posterior pair. These gland cells contain markedly granular contents, do not take any stain and are yellow brown in colour. They are clearly seen with their sharp dark outlines in the extended condition of the larva under high magnifications. The posterior set comprising three pairs of grayish coloured glands is distinctly distinguished from the anterior circum acetabular glands. This set consists of smaller, less granular and consequently less prominent cells which fill more or less the remaining posterior part of the body. The three pair of the glands of the posterior set do not extend behind upto the posterior end of the body. In a specimen stained with borax carmine and mounted in canada balsam the glands of the posterior set along with their ducts take the red stain so nicely that they stand out in marked contrast with the unstained yellowish glands of the anterior set. The ducts from these five pairs of glands of the two sets run forwards in a bundle on eaeh side converging towards the median line and approaching each other in between the eyespots. As they pass laterally outwards the two bundles of ducts diverge away from each other and bend again medially to enter into the anterior organ at the level of the junction of its two constituent parts. Just at the point of entrance into the anterior organ, the ducts become very thin. Within the anterior organ, the ducts of the two sides take a wavy course *i.e.* approach and diverge away from each other at least once or twice before opening to the exterior. A number of spines are present at the anterior end in the region where these ducts open to the exterior.

The excretory system resembles much with that of *C. elvae* and *C. bombayensis* no 19. Six pairs of flame cells are present in the body. The V shaped excretory bladder devoid of an island of Cort lies at the posterior end of the body and gives rise to a pair of primary collecting tubes which run anteriorly in a convoluted manner upto the level of the ventral sucker. At this point they take a bend on the lateral side and then trun backwards for a short distance to give rise to anterior and posterior collecting tubules. This part of primary collecting tubes is ciliated. Each anterior collecting tubule receives capillaries from 3 flame cells, the first situated near the base of the anterior organ, the second behind the eyespot and the

third at a short distance in front of the anterior margin of the acetabulum. The posterior collecting tubule passes backwards to end in a flame cell located in the tailstem not far from the excretory vesicle. Three more flame cells situated in the posterior part of the body empty into the posterior collecting tubule. The most anterior of these three lies posterior to the acetabulum while the most posterior one is situated by the side of the excretory vesicle, the third one lying inbetween these two flame cells. Thus there are six pairs of flame cells in the body, three on each side emptying into the anterior and three into posterior collecting tubule. The seventh pair of flame cell is situated in the proximal region of the tail stem. The caudal excretory canal runs through the middle of the tail stem and bifurcates at the origin of the furcae, each branch passing upto its tip to terminate in the bulbous expansion which projects beyond the furcal tip.

There occurs behind the ventral sucker a mass of cells taking stain lightly and representing the primordium of the gonad. It measures, ·035 × ·041 mm. In the specimens stained with neutral red, a number of bodies coloured deeply red in the peripheral region of the body have been seen. They are large in number behind the eye spots.

The cercariae develop in sporocysts but they could not be studied as the snail had died and disintegrated before any examination could be made.

DISCUSSION

This cercaria, though it is similar to *C. ocellata* Laval. St. George and *C. gigantea* Faust (1924) resembles most closely *C. elvae* Miller, 1926 and *C. bombayensis* no. 19 Soparkar, 1926. It resembles the two latter species in the general form of body, tailstem and furcae, in the absence of the pharynx and presence of a capillary oesophagus dividing into two short caeca, in the post equatorial and usually protruding ventral sucker, a pair of compound eye spots, and in the general plan of the excretory system with six pairs of flame cells in the body and one pair in the tail stem and the two branches of the caudal excretory canal opening at the tip of the furcae. *C. bombayensis* no. 19 differs from this species in the absence of constrictions at the bases of the furcae and in the penetration glands being less prominent and without any differentiation into two sets. In *C. bombayensis* no. 19 there is one set of four pair of similar gland cells. The latter species also differs in the extent of the intestinal caeca which bending backwards extend upto the middle of the acetabulum. The excretory system also shows certain differences in the arrangement of the flame cells though the number is the same; and in the presence of an island of cort. My form differs from *C. elave* in the presence of furcal fin folds and bulbous expansions at the tip of the furcae. It also differs in the absence of an island of Cort in the excretory vesicle and a few other minor details. The above mentioned differences entitle the cercaria the rank of a new species. This cercaria is therefore assigned to the new species *C. sewati* n. sp.

Host—Limnaea luteola (Lamarck)

Location—Liver.

Locality—Sewait, Allahabad, U. P.

Cercaria sewatii, n. sp. comes under Miller's Group D(elvae) of apharyngeal brevifurcate distome carceriae along with *C. ocellata*, *C. bombayensis* no. 19, *C. elvae* and *C. gigantea*.

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ABBREVIATIONS

A. O	Anterior organ.
Acet ; V. S.	Ventral Sucker.
Ant. G.	Anterior gland.
Br.	Brain.
B. E.	Bulbous expansion.
E. S.	Eye spot.
E. V.	Excretory vesicle.
F.	Furca.
F. C.	Flame cell.
F. F.	Furcal fold.
H. G.	Head gland.
I. C.	Intestinal caeca.
Oes.	Oesophagus.
Pri. G.	Primordium of gonad.
Post. G.	Posterior glands.
T. S.	Tail stem.

STUDIES ON THE POPULATION OF ARTEMIA SALINA OF THE SAMBHAR LAKE, RAJASTHAN

By

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SUMMARY

The results of relative frequency, frequency index, population density and variance show that *A. salina* is distributed at non-random (Contagious distribution). The calculation of population density from the frequency of its occurrence gives erroneous results. Frequency should not be used as an indication of population density when the distribution is contagious. It is found that the optimum conditions for the growth of the population are more or less in between the maximum and minimum range of environmental conditions. It has been observed that the physical features of the lake, fluctuation in the concentration of chemical compounds and wind current influence the rate of mortality in the population.

INTRODUCTION

The occurrence of *A. salina* was reported from the Sambhar Lake, Rajasthan for the first time by one of us (Baid, 1958). It is a very variable species found practically in all inland salt lakes. By reviewing the old literature on this genus (Verril, 1869; Schamankewitsch, 1875, 1877; Anikin, 1898; Gunther, 1900; Kellog, 1904; Artom, 1907; Abonyi, 1915; Jenson, 1917; Gajewski, 1922; Medewewa, 1922; Bond, 1933; Weisz, 1946; Goldschmidt, 1952) it is found that the main attention of the zoologists was focussed on the study of its variations with salinity and chromosomes and not on its population. Hence an attempt is made here to elucidate some problems concerning its population *i. e.* quantitative estimation of the population, relation of frequency index to population density, seasonal variation, mortality factors etc.

OBSERVATIONS

Quantitative estimation of the population :—

The quantitative study of the population is very important in the field of ecology. It gives concrete information regarding the relative abundance of various species which form one community. There are various methods for the determination of the population size (Allee, Emerson, Park and Schmidt, 1949). But these methods give better idea regarding terrestrial and tree boring animals and not of aquatic ones. But for the shallow lakes like the one in Sambhar, the fauna can be collected by hauling muslin net and the population can be studied quantitatively by counting the animals per haul. It gives a fairly good idea regarding the relative frequency of the population of different species. Here the population was estimated as space relative population. It is commonly called "Density of Population," *i. e.*,

$$\text{Density of population} = \frac{\text{Total number of } \textit{Artemia} \text{ collected from all stations.}}{\text{Number of stations.}}$$

The main places of the lake were visited every month during the year 1956 and 1957. The quantitative study of the population of *A. salina* was confined to Gudha and Japhog and the locality in between them. They are about three miles apart. The collection was made by muslin net of one litre capacity at ten different stations between Gudha and Japhog. This net served both for the general collection of the fauna from the lake and also for the quantitative estimation of the population of different species of crustaceans and insects. Every month one litre water was collected at random by the net. At the same time the number of *Artemia* were counted (Table. 1) and the population density was calculated by the above formula (Harding, 1957)

TABLE 1

Showing the number of *A. salina* per liter at different stations and density of population in different months.

Month	A	B	C	D	E	F	G	H	I	J	Total	Density of population per liter
July	—	—	—	—	—	—	—	—	—	—	—	—
Aug.	—	—	—	—	—	—	—	—	—	—	—	—
Sept.	10	6	12	—	—	15	11	9	17	14	94	9·4
Oct.	29	18	34	31	19	38	26	32	42	25	294	29·4
Nov.	42	48	37	32	27	45	52	44	35	40	402	40·2
Dec.	56	53	37	38	46	51	59	26	47	56	469	46·9
Jan.	59	64	68	48	53	42	66	54	60	59	573	57·3
March	9	5	—	—	—	—	6	12	11	7	64	6·4
April	—	—	—	2	—	1	2	—	2	—		0·7
May	The lake bed is dry.											
June												

Relative Frequency :—

The relative frequency of *A. salina* was calculated by counting them in the first 100 animals captured in one haul. The proportion represented by *A. salina* in the total count is its relative frequency. If the total number of organisms was not hundred it was calculated. The results are given in the table no. 2. The maximum relative frequency of any species can be 1·00 *i. e.* all the hundred animals are of the same species. The result of relative frequency shows that *Artemia* forms the major part of the community.

Frequency Index :—

The frequency index is another useful statistical device to describe the ecological distribution quantitatively (Raunkiaer, 1909; Smith, 1913; Gleason, 1920).

In order to calculate frequency index the presence or absence of *A. Salina* in each of the series of samples was recorded.

$$\text{Frequency Index} = \frac{\text{Number of samples in which the species is present,}}{\text{Total number of samples examined.}}$$

The frequency index, therefore, is a statement of the proportion in which a given species appears in a series of samples.

Relation of Frequency Index to Population Density :—

Frequency index is related to population density. The denser the population the greater is the proportion of samples in which the species will appear. The relationship between population density and frequency, however, is not directly proportional as has been pointed out by several ecologists (Kylin, 1926; Blackman, 1935; Ashby, 1935). A mathematical treatment of the relation has been presented by Fisher (1941). It has been shown by Cole (1946), however, that the population of the organisms living in nature is only rarely distributed at random. Our own observations on the fauna of the Sambhar Lake support this statement and suggest that the distribution of the most of the animals is not at random.

It is then desirable to determine how much error can result from the calculation of population density from frequency counts made of population which is not distributed at random. In the table no. 2 we have presented the result of the relationship between frequency index and population density for the months of September, March and April. This relationship for the months of October, November, December and January could not be established because the frequency index is 1.00. The calculation of population density from its frequency index can only be done if the frequency index is below 1.00. It is evident from the table no. 2 that *Artemia salina* is not distributed at random over the area sampled. In a random distribution (Poison Series) the variance should be the same as the means. The actual variance of the counts on the sample plots, however, exceeds the means in every month showing that *A. salina* tends to occur in groups (Contagious distribution). Visual observation of the lake where the counts were made also showed that *A. salina* was more aboundant in certain parts of the lake than in others.

Because of the non-random distribution of the individuals of *A. salina* over the area examined the calculation of their mean population densities from their frequencies give figures that are inaccurate. In every month (September, March, April) the estimate of density calculated from the number of samples lacking any representative of the form, is much lower than the more accurate estimate made by counting all the individuals collected from all different stations on the same area (Table, 2).

It is evident, therefore, that the calculation of population density of a species from the frequency of its occurrence in samples of any kind may give erroneous figures when the distribution of the form is non-random. Thus frequency should not be used as an indication of population density when the distribution is contagious.

TABLE 2

Showing frequency index, relative frequency, mean calculated from frequency index, actual mean per sample and variance of *A. salina.*

Month	Number of Artemia per 100 animals	Relative Frequency	Frequency Index	Mean per sample calculated from index	Actual mean per sample	Variance
Sept.	5	0·05	0·8	0·16	0·94	30·84
Oct.	16	0·16	1·0	—	2·94	153·24
Nov.	40	0·40	1·0	—	4·02	52·6
Dec.	77	0·77	1·0	—	4·69	87·09
Jan.	82	0·82	1·0	—	5·73	69·81
March	23	0·23	0·7	0·12	0·64	63·9
April	20	0·20	0·4	0·05	0·07	0·801

Seasonal variation in the population of A. salina :—

The population of Artemia Salina shows variation according to the chemical condition of the lake water. The curve representing the seasonal distribution turns sharply upwards in November, December and January. When salinity is 72·6%, 76·6%, and 82·1% respectively. In March and April when salinity is 111·03% and 164·0%, the curve reverses its direction and ultimately becomes horizontal. This nature of the curve shows that in the begining there is little competition with other species and the curve moves upwards. Later on as the population grows the intraspecies competition becomes keen. All the mortality factors operate at a higher rate and the curve reverses its direction. On the whole the curve shows that the population of *A. salina* fluctuates with the condition of water in the lake.

It seems that the most favourable period for population is the winter season when food is in abudance, and all the evironmental conditions (salinity, temperature, pH value, oxygen and carbon-di-oxide contents of the water) are approximately half the way in between their maximum and minimum limits. In April very few specimens of *Artemia* were found in the lake (1/litre). This small number was probably not due to salinity but other factors, as high concentration of carbonates, bicarbonates and carbon-di-oxide and low percentage of oxygen. Before dying *Artemia* deposited a large number of eggs in the mud.

Mortality factors :—

Contitions of environment play an important role in effecting mortality of *Artemia* in the lake. These conditions are considered under the following heads :—

1. Physical conditions of the lake.
2. Seasonal variation in the contents of the lake water.
3. Wind.

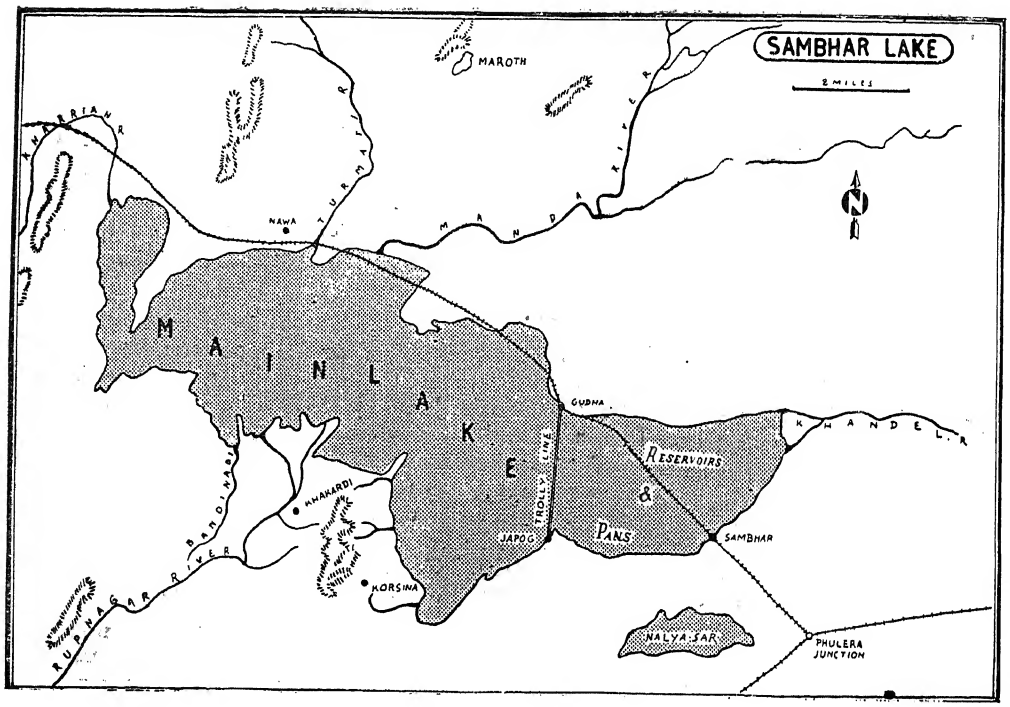

Fig. 1. Map of the Sambhar lake.

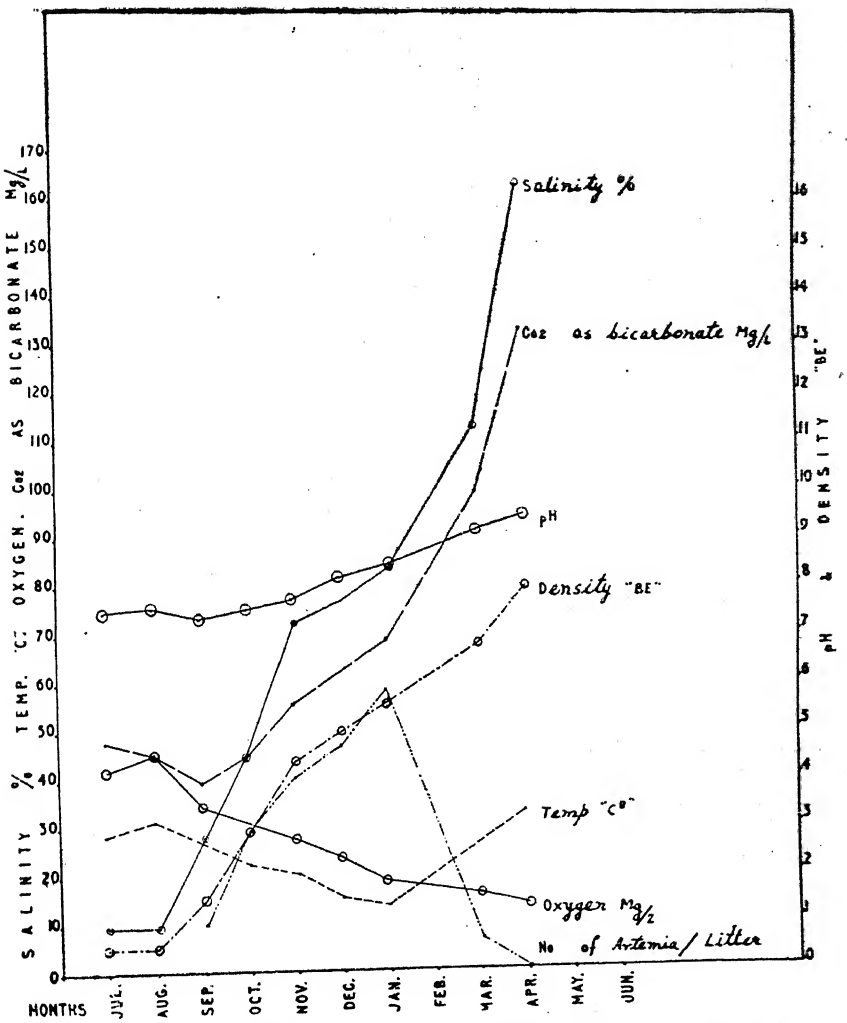

Fig. 2. Graph showing the distribution of *Artemia salina* and the changes in environmental conditions during different months of the year 1956-1957.

Physical conditions of the lake :—

The physical conditions of the lake are such that they adversely effect the population of *Artemia*. The lake is 22 miles long and 6 miles broad with an average depth of 2 feet. It is divided into two parts by a trolly line running between Gudha and Japhog (Fig. 1). One part is the main lake which extends towards the west and the south while the other extends to the east. The latter part is further divided into pans and reservoirs. The water in the main lake is brought by streams during rainy season and collects there till it attains 30Be. Then it is pumped into the canals slowly and slowly. From the canals the water is again pumped into pans where it is allowed to stand to yield salt. The natural population of *A. salina* is highly disturbed due to this pumping of water from the main lake.

Seasonal variation in the contents of the lake water :—

Besides the seasonal variation in the concentration of salinity, the oxygen and carbon-di-oxide contents and the formation of bicarbonates are also very important factors effecting the mortality rate. In the month of March and April the percentage of dissolved oxygen in the brine was very low and that of carbon-di-oxide increased very much. And probably this condition was responsible for high death rate of *Artemia*. In April as many as 62 dead *Artemia* have been recorded. The death is probably due to lack of oxygen and excess of CO2 contents. Carbon-di-oxide in the lake is also produced by bacteria which break up cellulose of dead algae into simpler compounds and CO2. Davidson (1944) cites the work of others of that the experimental studies show that an increase in blood acidity in fish and others destroys red blood cells. Similarly there is possibitity that the increase in carbon-di-oxide might be having a toxic effect on the natural population of *Artemia*. The conversion of sodium sulphite into sodium sulphate and its further reactions to form hydrogen sulphide also greatly influence the population of *Artemia* adversely.

Wind :—

Wind causes movements in the water of the lake. And these movements also effect death rate of *Artemia*. The wind generally blows from east to west (Pramanik, 1954), taking the water waves in the same direction. As the lake is not deep the water is disturbed from the surface to the bottom. And *Artemia* are thrown on the bank in large number.

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opening of the oesophagus is not guarded by any oesopahgeal valve. The major part of the wall of the first section of the ventriculus is lined by large elongated or flattened cells with prominent nuclei. The wall of the third section of the ventriculus (3rd ven) not in contact with the first section of the ventriculus (1st ven), is lined with a few giant cells (gc), which, although present on one side, virtually occupy the entire space of the third section of the ventriculus. Each of these giant cells carries a large oval or elongated nucleus. The histological details on either side of the line of contact of the two chambers are similar. The two walls are inseparably united together and their cellular nature is reduced to a mere thin cytoplasmic strip without any distinct cell-wall.

IV. DISCUSSION

It is clear from the above observations that the adjoining walls of the first and third sections of the ventriculus throughout their course are reduced to mere thin cytoplasmic strips and are inseparably united to each other. Such a distinct union between these two parts is absent *Tricentrus albomaculatus*. If Berlese theory (1909) of working of the filter-chamber, though not supported by any experimental proof, yet accepted by Snodgrass (1935), Wigglesworth (1942), Imms (1948), Ross (1948) and a number of other workers, is taken to be correct, the observation in *O. tarandus* Fabr., lead the author to believe that the fused wall of the first and third sections of the ventriculus in some way allows the excess of water present in the insect-food to pass directly from first section to third section of the ventriculus and thence to the intestine.

V. SUMMARY

The filter-chamber in *Oxyrhachis tarandus* Fabr. is formed by a close association of two distant parts, i.e., first and third sections of the ventriculus or mesenteron. It is enclosed within a connective tissue sheath. The first section of the ventriculus forms a major part of the filter-chamber receiving food supply from the oesophagus. The third section of the ventriculus follows a zigzag course running up and down on the surface of the first section of the ventriculus. Throughout its course it maintains a close inseparable union with the first section of the ventriculus. The cellular nature on either side of the line of union is wanting. The entire area is reduced to a thin cytoplasmic strip, which in some way permits the excess of water to pass directly from the first section to the third section of the ventriculus and thence to the intestine.

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